POWER

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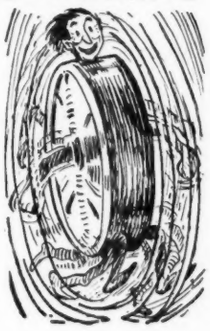
THE MASTER'S HAND

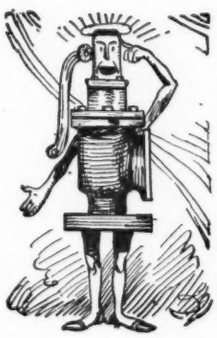
BY BENJAMIN O. WILKINS

The Governor: "I dance serene,
On top of all the great machine,
And glance around, by night and day,
To see that things don't run away."



The Flywheel hummed, "Here, think of me—
Momentum lost, where would *you* be?
Who drags you on with iron nerve
Up from the bottom of the curve?"

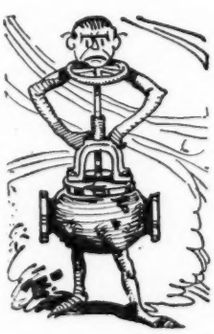
"Who? You? You're nothing but a shirk!
It's me, The Piston, does the work.
I'm here with might to push and pull,
And make each stroke count to the full."



The Safety Valve spoke up and said,
"Without me and my knowing head
The lot of you would fly apart,
And land in the old-iron mart."

"Oh, no! You but obey *my* will,"
The haughty Steam Chest hisses shrill.
"I am the one that gives the strength
To shove you out the guide's full length."

The Engineer came over then
And said, "She's got a grouch again.
Why! That blamed oiler's shaken loose!
Without the grease she's little use."



And then the Throttle Valve got cross:
"I'm over you, and I'm the boss
Of all your energy and zest.
Now tell me, which of us is best?"

A Visitor was looking in.
He shook his head: "Of all the din!
What good would that huge engine be
Without the man, to oversee?"

Generator Wreck at St. Paul

ON TUESDAY morning, Dec. 10, in the St. Paul plant of the Northern States Power Co. a 2000-kw. generator which had been in service for nine years was completely damaged. The trouble originated by a workman short-circuiting a 13,000-volt feeder in Minneapolis connecting the St. Paul and Minneapolis plants. The St. Paul plant, in which were operating one 1000-kw. and one 2000-kw. steam-turbine units, excited from a motor-generator set, was subjected to a short-circuit of such proportions and duration that the excitation was practically lost on both the turbo-generators. About the time the steam-driven exciter was put in operation the generator end of the 2000-kw. unit completely wrecked itself. It is noteworthy that the steam end of the turbine remains intact, as clearly shown in Fig. 1, although probably the shaft has been sprung and the casting supporting the turbine bearing has been cracked. The generator and its bedplate are completely wrecked. The field shaft is broken off at each end of the field, and three polepieces were thrown off. The inboard and outboard bearings are demolished. The completeness of this generator wreck is shown in Fig. 1, and Fig. 3 is a view of the spindle shaft that was twisted off between the steam end and the generator.

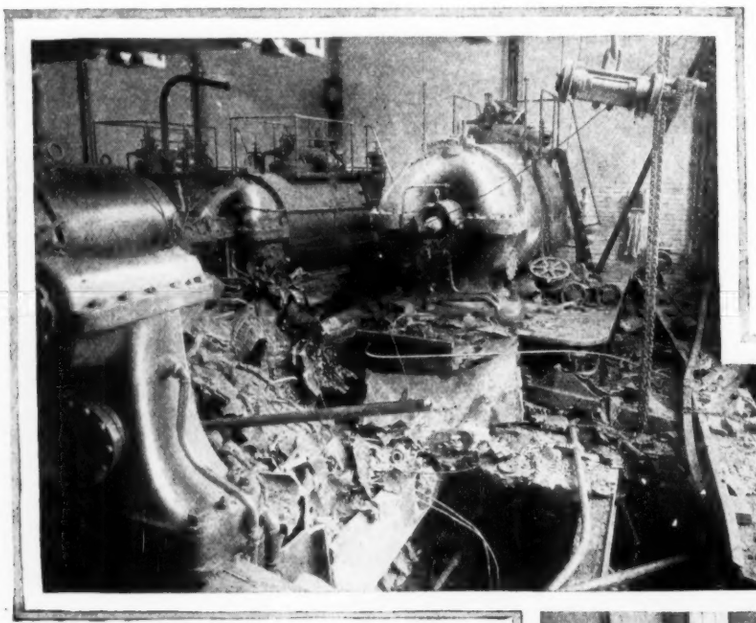


FIG. 1. VIEW OF THE TURBINE ROOM AFTER THE ACCIDENT

In addition to the units mentioned, there were in the station another 1000-kw. machine and a 4000-kw. unit, neither of which were in operation. The turbine driving the wrecked generator was a Westinghouse type C machine (a type abandoned several years ago, the patterns for which had been destroyed). At a speed of 1200 r.p.m., the generator delivered three-phase 60-cycle 2200-volt current. It has a built-up field having six polepieces of the bolted-on type. Each polepiece was held by 14 bolts, 2½ in. diameter. The unit weighed 169,000 lb., the turbine weighing 120,000 lb. and the generator 49,000 pounds.

Pieces from the wreck were thrown through the walls and about the power house, one complete section of wall near the generator being blown out. One piece cut the 20-in. I-beam of the overhead crane, allowing it to fall on the wreck. Another piece demolished the benchboard from which an operator had turned but a few seconds before. A large section of stator iron was shoved against the 100-kw. set running next to the wrecked machine, moving it and the bedplate more than two inches at the generator end and cracking the end housings of the generator.

No obvious or exact determinations have as yet been given for this wreck, but certain conclusions that may be illuminating can be drawn. The 2000-kw. and the 1000-kw. turbo sets were operating noncondensing and in parallel. The St. Paul plant was tied in with Minneapolis through one 13,000-volt three-phase feeder approximately ten miles long. The St. Paul turbo-generators were excited from a motor-generator set from which some power-house lighting was also done.

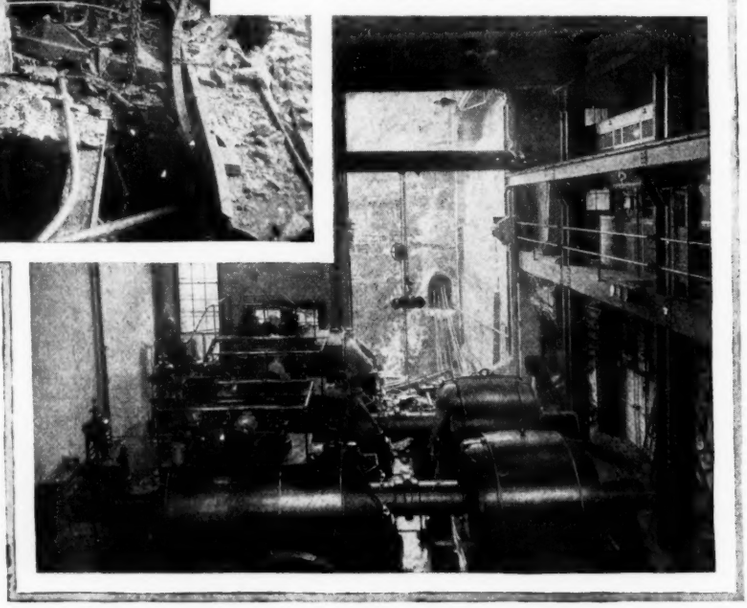


FIG. 2. WHERE THE GENERATOR WENT THROUGH THE WALL

A "short" occurred in Minneapolis by a man getting across this 13,000-volt feeder. This "short" remained on for sufficient time to allow starting the steam-driven exciter in the St. Paul plant—probably five minutes. It caused a slowing down and a reduction in frequency and voltage of the two units in operation. The motor-generator excitation voltage was so low that the lamps on the circuit were merely red, causing the short-circuited turbo sets to drop their load, though the turbine was getting all the steam it could pass.

With these conditions one of three things happened:

1. The machines being subjected to this short-circuit for several minutes caused the mechanical collapse of the 2000-kw. unit.

2. The machines remained on the short-circuit until it was cleared, and the entire system, many times 3000-kw. capacity, endeavored to bring them into step.

3. The machines under this terrific short-circuit overload, dropped their load, due to loss of excitation, and the 2000-kw. unit overspeeded until the generator exploded.

Assumptions must again be made, as no information is available as to why the circuit-breakers did not cut off this overload instantly, but obviously allowed the short to remain on both the St. Paul and Minneapolis systems until at least the 2000-kw. generator was wrecked. The first reason given can be dismissed, as a short-circuit located at the end of a ten-mile feeder would not wreck mechanically the machine, and as no smoke or blaze was noticed, the machine was not burned out electrically. This is also confirmed by the fact that the 1000-kw. machine in parallel on this short was not injured. It is difficult to justify No. 2, that the wreck was due to the machines getting out of step with the system, for if this was sufficient to wreck the 2000-kw. generator, it certainly would have had some effect on the 1000-kw. unit. If it was sufficient to twist off the 8-in. shaft on the larger machine, it would likely have left some indications of strain on the smaller set. Inspection showed no internal damage to the smaller unit.

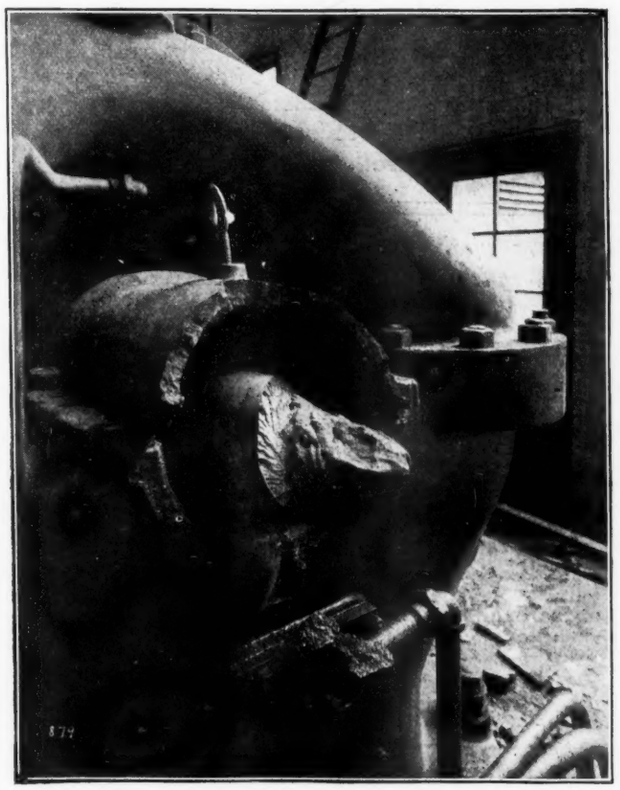


FIG. 3. THE SPINDLE TWISTED OFF

Overspeeding, as per No. 3, seems by far the most probable cause. The turbines had been in service nine years, were built for 150 lb. steam pressure and no superheat, and were actually operated under 185 lb. steam pressure, 100 deg. superheat and 6 lb. back pressure. Owing to this changed steam condition, the company operating the plant had dismantled the automatic safety stop on the three type C machines, depending upon the system to lock them electrically and load changes to be handled by the regular governor operating on the primary and secondary valves. Both of these valves were opened to the maximum on the short and the machines operating at much reduced speed. When the load was dropped, owing to the loss of excitation, the generators instantly speeded up. The governor on the 1000-kw. turbine closed its valves and kept the machine at normal speed under steam. The valves of the 2000-kw. turbine did not close tight, or for some other reason the governor did not control this machine. The overspeed trip actually tripped, but as the automatic safety stop was dismantled, it was useless and the generator reached a speed where the fourteen 2½-in. bolts per field pole, were elongated and the poles struck in the stator, which twisted off the shaft and wrecked the machine.

Only one operator in the power house was slightly injured. The operator in Minneapolis who short-circuited the line was, of course, electrocuted. The property damage is about $50,000, covered by insurance. There was no material interruption to the electric service. The heating system into which the machines were exhausting, was discontinued for about one hour, but owing to mildness of the weather, this was immaterial. After one has carefully gone over the details of the accident, he sees that it is more spectacular than fraught with circumstances for technical thought. The lesson to be drawn from the accident is one for operators chiefly; namely, that the crew should exercise constant care to see that in the event of loss of load, the turbine will shut itself down without damage.

Sir Adam Beck, chairman of the Public Hydro-Electric Power Commission of Ontario, Canada, which is now serving over 200 cities, reports that power developed under public ownership on the Canadian side of the Niagara Falls sells at a wholesale price of $9 per horsepower, while the same power developed under private ownership just across the river on the American side sells at $18.

The best way to lubricate gears is to clean them and then paint the cogs with a stiff brush. Where this is not possible, the lubricant may be poured on the cogs while the gears are running. The lubricant should be poured where the gears mesh.

Behavior of Steam in a Compound Engine

A STUDY of the pressures at various stages or points of the stroke in an engine becomes absorbing when once begun, and is one of the numerous questions that must be decided or worked out by the designer before the engine is completed. Suppose the cylinder dimensions of a tandem-compound engine have been fixed at 100 sq.in. area for the high pressure with 10 per cent. clearance, and 300 sq.in. for the low pressure with 5 per cent. clearance, both having a common stroke of 15 in. Dividing the stroke into ten equal parts gives 150 cu.in. for each one-tenth of the high-pressure cylinder stroke and 450 cu.in. for the low-pressure cylinder. Using a receiver having a capacity of 4725 cu.in., the total volume of the high-pressure cylinder plus the receiver and the clearance space for the low-pressure cylinder (with the low-pressure admission valve just opened) would be 1650 (the high-pressure cylinder) plus 4725 (the receiver) plus 225 (the low-pressure clearance volume), a total of 6600 cu.in. The steam pressure is fixed at 140 absolute (125 gage). Both valves are operated by the same eccentric or automatic governor. Under these conditions what will be the receiver pressure and the terminal pressure when operating noncondensing with a cutoff taking place at $\frac{1}{10}$ stroke in each cylinder?

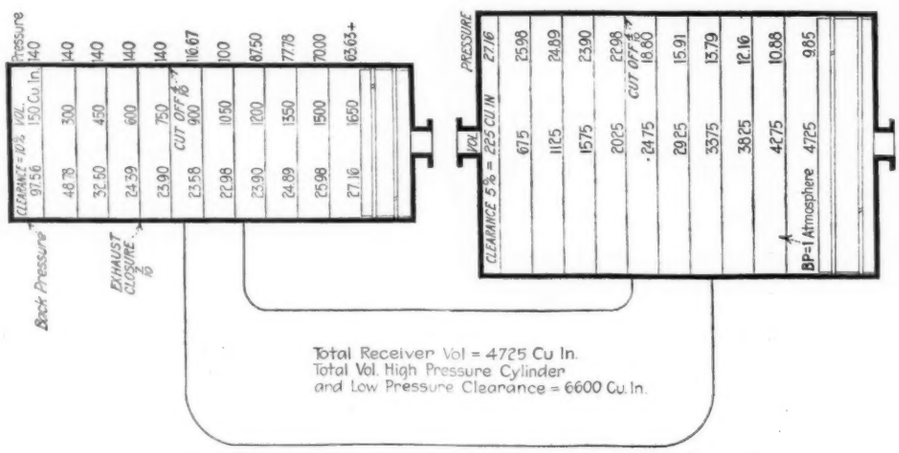
Did you ever wonder how the designer of a compound engine computed and decided the cylinder proportions to be used?

Did you ever wonder why the receiver pressure is what it is, in the engine you have to do with?

Can you explain why the receiver pressure is the same for all variations in load, if it is, or why it varies, if it does?

In this article is an informal discussion of these points, in which the influence of valve adjustment and governor control is pointed out.

Starting the engine after a thorough warming up and with steam at atmospheric pressure (15 lb. absolute) in the receiver space, the pressures at various points of the first revolution of the engine would be as shown in the illustration, neglecting condensation losses and leakage and treating the steam as if it were a perfect gas, following the $P \times V =$ constant law. In other words, a change in the space or volume occupied by a given quantity of steam changes its pressure proportionately, so that the original volume (V) multiplied by the original pressure (P) and divided by the new volume will give the resultant pressure. Then if the steam is cut off at the point when the initial steam occupies one-half the final volume of the cylinder at the end of the stroke (clearance volume included), the final pressure will be one-half the initial pressure. If cutoff at one-fourth the final volume, the final pressure will be one-fourth the initial, etc. Steam does not follow this law exactly, but it is the basis of all calculations of this nature. The clearance space in the high-pressure cylinder, being 10 per cent., is equal to $\frac{1}{10}$ the piston's displacement, or 1½ in., and cutoff taking place at $\frac{1}{10}$ of the piston's travel, there is at cutoff a volume of 750 cu.in. (600 cu.in. by piston and 150 cu.in. clearance) filled with steam at 140 lb. After cutoff the pressures at each succeeding $\frac{1}{10}$ of the stroke, or 1½ in. the piston travels, will be 116.67, 100, 87.5, 77.78, 70 and 63.636 pounds respectively. When the high-pressure exhaust opens, this 1650 cu.in. of steam expands into the receiver (4725 cu.in.) and clearance space (225 cu.in.) of the low-pressure cylinder in addition to the volume of the high-pressure cylinder (or a total of 6600 cu.in. space), but the receiver and low-pressure clearance space, amounting to 4950 cu.in., is filled with steam at atmospheric pressure, or 15 lb., so that 4950 × 15 equals 74,250, and the high-pressure cylinder discharges 1650 × 63.636 (or 750 × 140) equals 105,000. The sum of the two is 179,250 and this divided by 6600 (the total volume) gives a combined pressure of 27.16 at the beginning of the low-pressure stroke. As the two pistons move forward, the steam pressure decreases proportionately as the total volume occupied by the steam increases. The increase in volume for each $\frac{1}{10}$ of the return stroke is 300 cu.in.; since the low-pressure volume increases 450 cu.in. and the high-pressure volume decreases 150 cu.in., the net increase is the difference, or 300 cu.in. This rate of increase continues up to the point of cutoff of the low-pressure cylinder, and the corresponding pressures are: Begin-



COMPUTATION OF PRESSURES FOR GIVEN CONDITIONS

ning of stroke, 27.16 lb.; at the end of the first stage ($\frac{1}{10}$ stroke) (1), 25.98 lb.; (2), 24.89; (3), 23.90; (4), 22.98, when the low-pressure steam valve closes and the total remaining volume is reduced by 150 cu.in. per stage until the high-pressure exhaust closes, at $\frac{7}{10}$ of the return stroke, and the steam pressure increases proportionately to (5), 23.58; (6), 23.90; and (7) 24.39, when the exhaust closes and compression within the high-pressure cylinder brings the pressure (compression) at $\frac{8}{10}$ to 32.50; (9), 48.78; and (10), 97.56 at the end of the high-pressure return stroke. While this has been going on in the high-pressure cylinder, the steam isolated in the low-pressure cylinder after cutoff has taken place, expanded from 22.98 at cutoff as follows: (5), 18.80; (6), 15.91; (7), 13.79; (8), 12.16; (9), 10.88; and (10) 9.85 lb. pressure at the end of the low-pressure piston stroke.

The high-pressure cylinder has been receiving a fresh charge of high-pressure steam on the opposite side of the piston in the meanwhile, and cutting off at the same point, its expansion and terminal pressure will be the same as before, but the receiver this time will contain steam at the pressure present at the time of the previous high-pressure exhaust closure, or 24.39 absolute, as against 15 lb., or atmospheric pressure, assumed at first, so that the receiver pressure at the beginning of the second low-pressure stroke will be 34.20 lb., and at cutoff 28.93, and the end of the stroke 12.40, and in the high-pressure cylinder at its exhaust closure 30.71 compressed up to 122.84 at the end of the return stroke. The pressures at these points for succeeding strokes, carried out until the receiver pressure becomes practically stationary, are shown in the table.

STEAM PRESSURE AT VARIOUS POINTS OF THE STROKE

	Beginning of Low-Pressure Stroke	Low-Pressure Cutoff	Low-Pressure Terminal	High-Pressure Closure	High-Pressure Compression
(1)	27.16	22.98	9.85	24.39	97.56
(2)	34.20	28.93	12.40	30.71	122.84
(3)	38.94	34.27	14.69	34.97	139.98
(4)	42.14	35.65	15.28	37.83	151.32
(5)	44.28	37.47	16.06	39.76	159.04
(6)	45.72	38.69	16.58	41.06	164.24
(7)	46.70	39.52	16.94	41.94	167.76
(8)	47.36	40.08	17.18	42.53	170.12
(9)	47.81	40.45	17.33	42.93	171.72
(10)	48.11	40.70	17.44	43.20	172.80
(11)	48.31	40.87	17.52	43.38	173.52
(12)	48.45	40.99	17.57	43.50	174.00
(13)	48.54	41.07	17.60	43.58	174.34
(14)	48.59	41.12	17.62	43.63	174.52
(15)	48.63	41.15	17.63	43.67	174.68
(16)	48.66	41.17	17.64	43.69	174.76
(17)	48.67	41.18	17.65	43.71	174.84
(18)	48.69	41.20	17.66	43.72	174.88
(19)	48.70	41.205	17.661	43.73	174.92
(20)	48.71	41.21	17.661	43.736	174.94
(21)	48.712	41.217	17.662	43.7406	174.96
(22)	48.714	41.22	17.665	43.743	174.97
(23)	48.716	41.221	17.666	43.745	174.98
(24)	48.718	41.222	17.667	43.7466	174.986

It will be observed that the pressures all gradually increase except the high-pressure (forward) stroke, which of course remains the same throughout. If, therefore, the calculation is carried forward for a number of strokes, as given in the table, the pressure conditions for the other events will presently become stationary; that is, the receiver pressure will become fixed, with only slight pulsations of a pound or two. The volume of the receiver on a tandem-compound engine is seldom greater than the necessary connecting pipe and in any case does not affect the pressure except to reduce pulsation. It is not necessary, however, to follow the calculation step by step as the engine is started up. This was done in the foregoing, as a matter of interest that the operating man can observe for himself any day in starting up, by watching the gradual building up of the receiver pressure. The designer can do what the operator may also do; namely, put steam of any desired pressure into the receiver to start with, then calculate or watch the pressure change increase or diminish, depending on the amount and direction his "guess" is off, and the number of computations will not be great. It will be seen that some changes in valve dimensions or setting will be necessary in the case given, since the high-pressure compression is too high. If operating condensing the low-pressure terminal pressure is too high, but if the engine is exhausting into the atmosphere or a low-pressure heating system at about 2 lb. gage pressure, this feature would be about right. To bring the compression pressure just up to and not above that of the initial steam (140 absolute) in a space of 150 cu.in. (the clearance), it must be 70 lb. at $\frac{9}{10}$ stroke in 300 cu.in. (double the space) and 46⅔ lb. at $\frac{8}{10}$ stroke, so that it may be seen by inspection of the table of pressures that exhaust closure in the high-pressure cylinder should be about $\frac{8}{10}$ stroke.

The whole problem must be worked out carefully for each case, for if the engine is designed to operate condensing, the low-pressure cutoff must be earlier or the receiver pressure considerably lower to get the expansion or terminal pressure in the low-pressure cylinder reasonably near the vacuum maintained in the condenser. If, however, the low-pressure cutoff is set earlier (the low-pressure cylinder taking less steam) the receiver pressure will naturally increase, defeating the object of the early cutoff by admitting steam at a higher pressure for the shorter period offsetting the early cutoff. The high-pressure cutoff may be shortened so there will be less steam thrown into the receiver, but less power will be developed.

Effect of Cutoff on Receiver Pressure

The changes in receiver pressure produced by a change of cutoff as affected by an automatic governor in control of both valves and also when only the high-pressure cutoff is changed, are as follows: In the latter case it is obvious that the receiver pressure will increase with a late high-pressure cutoff, with the low-pressure point fixed, but when both are changed the resultant receiver pressure may be higher, lower, or remain the same, depending on the relative points of cutoff and the original proportion or capacity of the cylinders. Suppose, for example, the capacity of the low-pressure cylinder was double that of the one given; then with both valves cutting off the same as before, the receiver pressure would obviously be proportionately lower. When both are changed by the governor, the receiver pressure may be increased, diminished or remain the same, depending on the relative point of cutoff of the two valves, while the amount or rapidity of the change (in receiver pressure) will depend on the relative size of the two cylinders. For example, in the case worked out both valves cut off at the same point ($\frac{4}{10}$ stroke), and if both are shifted to cut off at any other point the proportion will remain the same (except for the slight difference in clearance volume) and the receiver pressure will remain practically the same for any cutoff. This also holds true for any other relative cylinder proportions when the receiver pres-

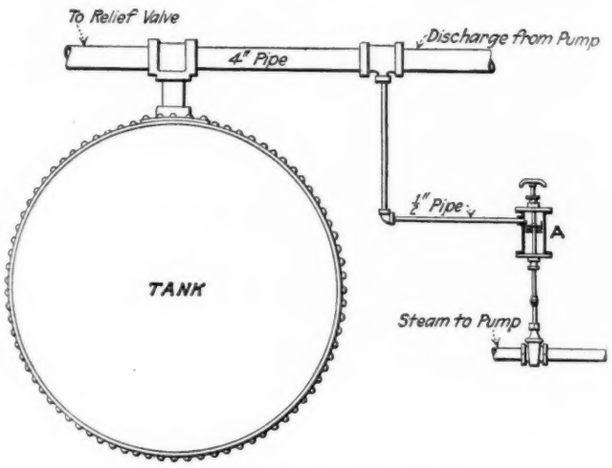
sure is once established. If, however, the valves are set differently, so that the high-pressure valve cuts off earlier than the low-pressure, the receiver pressure will not only be lower than in the example but it will change as the cutoff to both cylinders is varied by the governor. The shorter the cutoff the lower the receiver pressure will be, and as the cutoff lengthens the receiver pressure will increase. The reverse is therefore true if the high-pressure cutoff is made later than the low-pressure cutoff, and the greater the difference in point of cut off and in the cylinder ratios the greater the variation will be in each case.

Confining the changes to such valve adjustments as are possible with a Corliss-type valve gear, it will soon develop that the limitations are narrow, for as already stated, in order to get a reasonably low terminal pressure at the low-pressure exhaust valve opening, the cutoff must be early or the receiver pressure low. To get less steam into the receiver the high-pressure cutoff may be made early, but the power of the engine will be cut down. In short the possible number of expansions is determined by the point of cutoff in each cylinder and the relative capacity of the cylinders, so that the range of power economically developed by an engine of certain proportions is limited. It should be borne in mind that the calculation of the ratio of expansion must terminate with the low-pressure exhaust opening and not be carried beyond, to the back-pressure line, as is often erroneously done. Useful work by the steam against the piston stops when the exhaust valve opens, and the drop from the pressure at exhaust opening to that of the terminal or back pressure is lost energy. It is true, of course, that the back pressure should always be kept as low as possible in the interest of economy and greater power in the engine, but that is "another story."

The drop in pressure between the high-pressure exhaust opening and the receiver pressure does not represent a loss in the same way, however, for the drop in pressure is represented in a proportionate amount of work done on the escaping steam, producing heat. The steam in the receiver is of better quality (it may be dry saturated or slightly superheated) by reason of this drop in pressure without doing work. A drop in pressure between the final exhaust opening and the back-pressure line if the heat in the exhaust is not utilized in some other way, is wasted, and if operating condensing it is not only lost but is detrimental in putting heat into the exhaust to be got rid of in the condenser.

Home-Made Automatic Pump Stop Valve

In a certain instance water was pumped into a closed iron tank. Help was scarce and the relief valve would occasionally be open for a considerable time before someone came along and shut off the steam supply to the pump. Finally, the stop device shown herewith was made. It consisted of two stuffing-boxes which were attached to the ends of an old 3-in. diameter pump cylinder taken from an iron hand pump. A ½-in. hole was drilled and tapped in the side of the cylinder for a pipe, which was connected to the pump discharge pipe. The cup leather of the old plunger was used with an iron washer behind it. A ⅜-in. rod passes through all and is fastened to the stem of a lift gate valve, a handle being fitted to the top of the rod. The whole is shown in the illustration. To start the pump the handle is raised; this admits steam to the pump cylinder, and the friction of the packing in the stuffing-boxes holds the valve in an open position. When the tank is filled, the pressure rises and, backing down

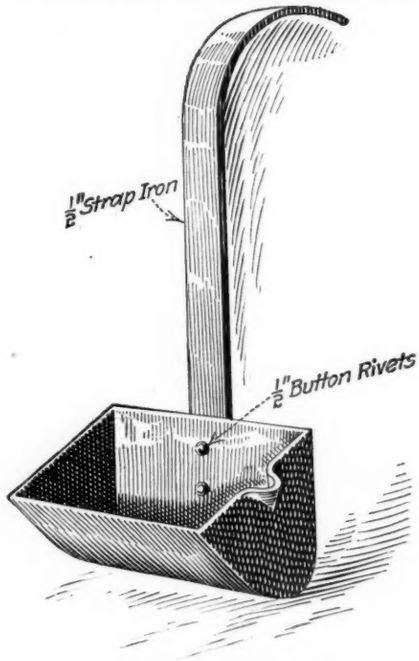


PIPING AND VALVE CONTROL

through the ½-in. pipe, forces the cup piston in the cylinder down, thus closing the steam valve. The relief valve was set to open at 10 lb. pressure.

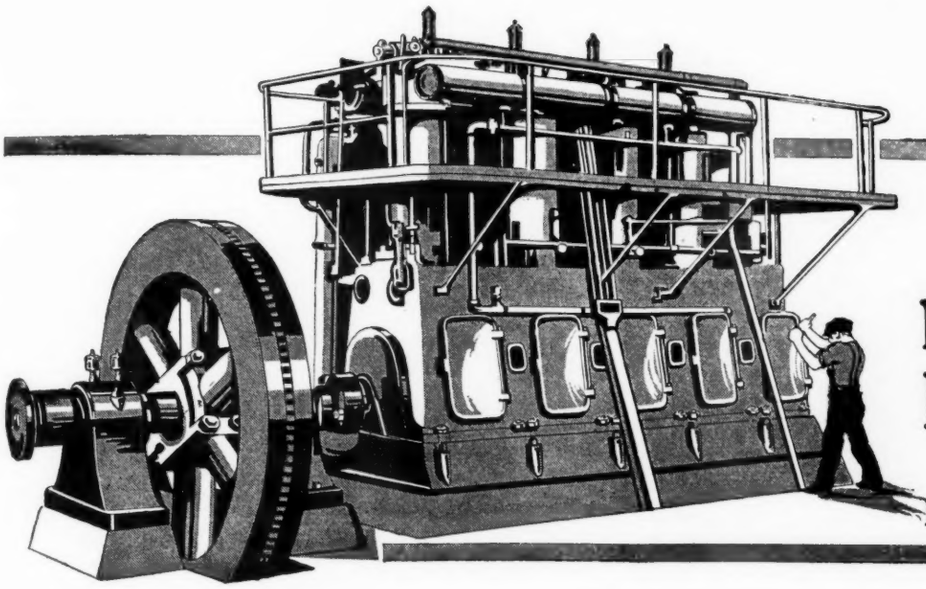
Simple Pouring Ladle

An easily constructed, serviceable grease or molten-metal ladle, says *Engineering and Mining Journal*, may be easily made from an old elevator bucket of the proper size by fastening thereon a handle of strap iron



A HANDY POURING LADLE

shaped to suit the requirements or the fancy of the user. As shown in the illustration, two ½-in. button rivets hold the handle securely in position in the center of the cup. If desired, a lip may be shaped on one end of the cup for ease in pouring.



Talks on DIESEL Engines

by L. H. Morrison

II—Egan gives some pointers about the work of setting and lining up a second-hand Diesel engine, and explains how to take up wear in the crankshaft bearings.

THE hour set for the first regular meeting of the Diesel-engine study class found the entire force of the plant gathered around a long table that Egan had managed to obtain from the stockroom.

"I'm glad to see that we're all here," J. R. began. "It shows that we want to learn—all we need is the opportunity."

He turned to the day watch engineer, who was seated at the same side of the table.

"By the way, Kelly, the Runner Refining Co. asked me to let them have a man to set up an American Diesel they've bought second-hand. I told them I'd send you over in the morning. Are you ready to tackle the job?"

"Sure," was Kelly's quick come-back. "They should do the worrying. But there's one thing I'd like to know before I go. How do you line up the mainshaft?"

"I thought you'd ask that question," said the chief. "So I fixed up a few sketches, showing how we erected that old Diesel over there in the corner. You can probably improve on the method, but it will give you the idea.

"This sketch, which we will call Fig. 1, shows an end view of the engine with the cylinders in place. The top surface of the frame is planed to receive the cylinders, of which there are three.

"Now, the first thing to do is to get the frame on the foundation. You'll probably find that the foundation bolts are fixed at their lower ends and project above the foundation some six inches. If the frame is bolted on to skids, move it to the foundation, jack it up to let it clear the tops of the bolts, and unbolt the skids. Then crib it up with timbers and move it onto the foundation. Next, jack it up with jacks set in recesses in the foundation at the four corners, as in Fig. 2, remove the timbers, and lower the frame to the foundation. But don't forget to put about a dozen iron wedges under the frame, around the edges. Some erectors use wooden wedges, but these are likely to split in driving. Leave the iron wedges in place after the engine is lined up, for they come in mighty handy if the frame ever settles."

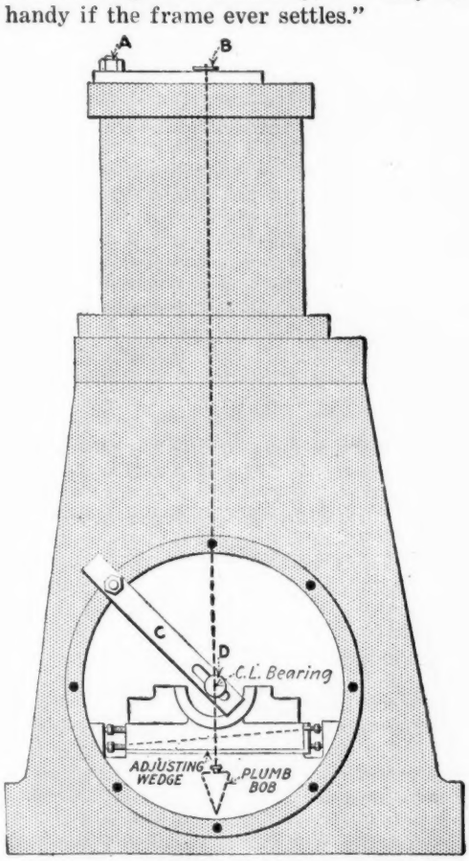


FIG. 1. LINING UP CYLINDER AND CRANKSHAFT

"What's the best way to level up the frame?" someone asked.

"Since the top surface of the frame is planed, put a spirit level on it and wedge up the low corners until the frame is level. Then run in grouting and let it set for a couple of days before you put on the cylinder castings."

"What's the best kind of grouting, Mr. Egan?" It was Woods who asked the question. "When we put in the hot-ball engine at the mill, we used sulphur."

"Melted sulphur used to be the common grouting material," J. R. answered, "but of late years most erecting men use neat cement. That's what I would use." He turned again to Kelly. "I'd advise you to see that the grouting is well troweled under the frame," he said. "Afterward, fill around the oil pan with cement to make a neat-looking finish."

Kelly was sitting on the edge of his chair, taking in all that was said. Egan continued:

"When the frame is set and bedded in, the cylinders can be put in place and bolted fast. This is not difficult, but be sure you draw up on the studs with the same tension. At this stage, Kelly, you have reached the point where you say you feel dubious.

"Now, there are four bearings—one at each end of the frame and one between each pair of cranks—which must be put in line, and their center line must square with the three plumb-lines let fall through the centers of the three cylinders.

"From a piece of hardwood 1 in. thick cut three strips and shape them to the dimensions shown in Fig. 3. Slip the large end over one of the cylinder studs and hold it in place by a nut, as at *A*, Fig. 1. Move the free end until the slot is over the center of the cylinder. Cut three thin metal disks about 1½ in. in diameter and punch each to receive a plumb-line. Drop the plumb-line through the cylinder, pass the upper end up through the slot in the wooden arm and fasten it to the metal disk *B*. The disk can then be shifted so as to center the plumb-line in the upper end

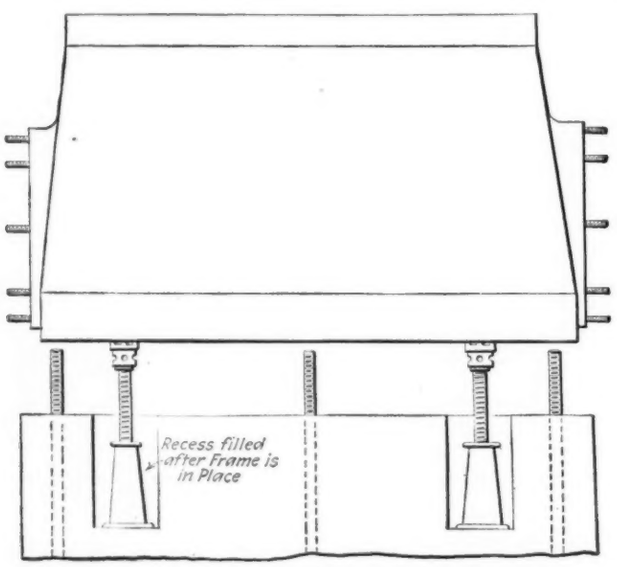


FIG. 2. LOWERING FRAME ON FOUNDATION

of the cylinder. Do this with each cylinder. Use fine piano wire for the line and see that the bob is heavy and that it hangs well below the bottom of the bearing.

"If the engines were new, I'd suggest that you measure the cylinders at the lower ends to see if the plumb-lines were central at those points. If they weren't, you'd have to raise the cylinders and scrape the frame till the cylinder flanges could seat properly. But as the engines are old, the cylinders are doubtless worn and so you need to center the plumb-lines only at the top. You will probably find the plumb-lines will be in line In case the center one is a trifle off, loosen up the flange bolts and move the cylinder the necessary amount. This will be less than a sixty-fourth of an inch, and even though the bolt holes are reamed to size, a few blows with a copper mallet and sledge will do the work."

"But how am I goin' to square up the shaft with the three plumb-lines?" Kelly demanded.

Egan hesitated a moment before he replied. "If it

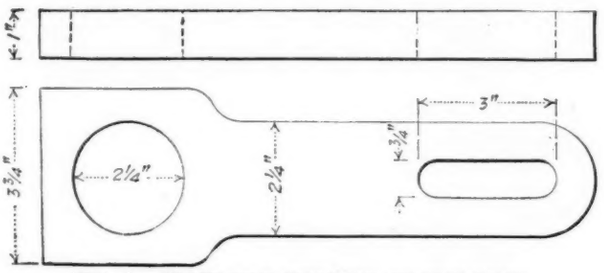


FIG. 3. STRIP FOR HOLDING PLUMB-LINE

wasn't of benefit to the rest of the boys, too, I'd be inclined to make you figure it out for yourself," he said, laughing. "On some engines there are gage holes at the ends of the frame, but these engines may not have them. So you'd better make two more hardwood or strap-iron strips and bolt them to the opposite ends of the frame, as shown at *C*, Fig. 1. Set them so that the slotted ends are opposite the center line of the mainshaft bearings and stretch a length of piano wire between them, using disks as shown at *D*.

"Now move the disks until the horizontal wire just touches the three plumb-lines, and level it at the same time with the spirit level. Caliper the four bearings and shift them until the horizontal wire is central in all of them. These bearings have wedge adjustments for height, and you'd better line them up with the wedges at their lowest points.

"Before you put the crankshaft in place, lay a piece of $\frac{1}{16}$-in. lead wire lengthwise along the bottom of each bearing. Then lower the shaft into the bearings and let it rest there. Next, raise it, take out each flattened wire and measure its thickness, which should be the same at all points. If it isn't, the shaft does not bear the full length of each box and it will be up to you to scrape the bearing to a perfect seat."

Woods interrupted with a question. "Why do those old Diesels have wedge adjustments on the main bearings while the new vertical engines here in the plant have no adjustments?"

"The first gas engines had nonadjustable bearings," explained the chief, "and there was trouble from damaged boxings and broken crankshafts. This was blamed on the bearings wearing out of line, which was probably true; but the remedy would have been larger bearing surfaces. However, the idea of using wedge adjustments on vertical engines was adopted and was followed by the first builders of Diesel engines. Of late years, builders have gone back to the wedgeless type."

"Which do you think's the best?"

"In vertical engines, the wedgeless," J. R. declared. "For instance, take the engines Kelly is to set up. I've no doubt he'll adjust the bearings to perfect alignment. But remember this—the outside bearings carry the

weight of the flywheels as well as their share of the pressure load, and they will wear faster than the inner bearings. This difference has got to be taken up sooner or later. If the engineer is a cheap man, who has no idea of how much care must be used, the result will probably be a bent shaft.

"On the other hand, if no wedges are used, the work of adjusting for wear requires a good man, and an ordinary operator won't try it. The up-to-date builder

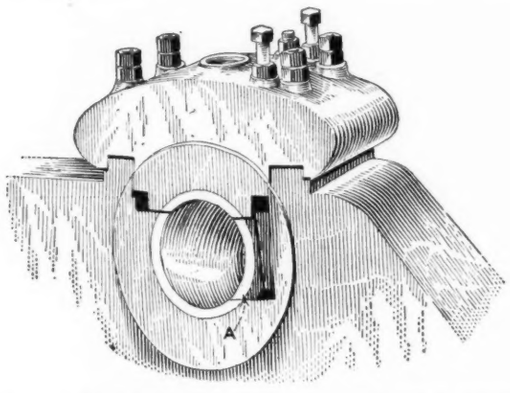


FIG. 4. MAIN BEARING WITH ADJUSTABLE FRONT QUARTER-BOX

scrapes his bearing housings to a test bar or shaft, and when this is done, all the lower bearings must naturally be of the same thickness. So it is only necessary to measure with a micrometer to find the wear on each bearing. To allow for this wear, sheets of copper or special laminated shims are placed between the housing and the bearing shell, and at the same time shims are removed from between the halves of the bearing to offset any play between shaft and shell. A good plan that I've followed here is to make a table of all the bearing-shell thicknesses. Then you're safe, even if the housings haven't been scraped."

"Chief, you said the outside bearings wore faster than the inside ones. Now, if there weren't any wedges, it seems to me you'd have to raise the shaft often to shim up those outside bearings," said Kelly.

"If all the bearings were the same length, your argument would be good. But on our four-cylinder 500-hp. engine the bearing on the side next the flywheel is about a third longer than the other ones. Also, the flywheel and the generator rotor are so located on the shaft extensions that most of their weight comes on the outboard bearing. On our other 500-hp. engine the shaft is of two-piece construction, also, but the bearing scheme is different. The entire weight of flywheel and generator rotor is carried by the two independent bearings. The reason for this construction is that the flywheel weight is constant while the pressure due to the explosions varies during each cycle. If the effect of the flywheel weight is confined to two independent bearings, the main bearing will wear evenly, and the outer bearings can be constructed so as to wear at the same rate, or to be adjusted easily if they don't."

"The people that build horizontal Diesels don't agree with you," spoke up Woods, who never left a subject until it was exhausted.

"That's a horse of a different color," laughed Egan. "The objection to the adjustable bearing doesn't apply to a horizontal engine. In fact, there is much in its favor. The wear in a horizontal engine comes on the front side of the bearing, which I have marked *A* in Fig. 4, and some form of adjustment is necessary to take up this wear. At certain points in the cycle the piston pressure becomes zero and the only bearing pressure is that due to the weight of shaft and flywheel, which acts downward. The shaft has a tendency to shift in the bearing at the point where the pressure changes, and if a two-piece bearing is used the operator will be kept busy shimming up. With wedge adjustment, the least wear in the quarter-box can be taken up.

"You'll notice that the rear quarter-box in Fig. 4 is not fitted with wedge adjustment. In some engines the rear quarter-box is cast with the bottom shell, on the theory that since no pressure is exerted on the rear quarter it will have no wear. This is true enough, but some method of adjustment is desirable. For instance, if the fuel oil varies and the compression pressure is to be changed, it can be done by means of these quarter-box wedges—moving the shaft inward toward the cylinder so as to alter the volume of the compression space; but it must be remembered that all bearing wear is taken up by means of the front wedge—that is, the one farthest from the cylinder.

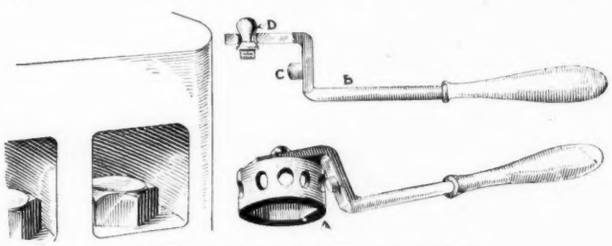
"If the engine has an outboard bearing, it would be dangerous for an inexperienced man to try to alter the compression by adjusting the front quarter-box. Of course, on all but the older engines the way to alter compression is by means of shims at the big end of the connecting-rod. The great advantage of having both quarter-boxes adjustable is the ease of taking up any and all wear."

J. R. pulled out his watch, glanced at it, and began to collect his sketches.

"It's time to quit," he announced. "Next Tuesday night we'll hear from Kelly as to how he's coming on with his erecting job."

Ratchet Wrench for Close Quarters

An engineer is often confronted with the task of loosening or taking up nuts located in restricted openings, as shown in the accompanying illustration, where they are almost inaccessible with a wrench of any ordinary type. To overcome this difficulty, says J. A. Lucas in



DETAILS OF A RATCHET WRENCH

Coal Age, I made the ratchet wrench shown to the right in the illustration. The hexagon part *A* of the wrench is made by forging a piece of suitable steel pipe around the nut and drilling holes on its circumference. The handle *B* is provided with a pin *C*, which fits the holes in the wrench body. It is fastened to the upper part of the wrench by means of a pin formed as shown at *D*. The operation of this wrench is self-explanatory.

Economies in the Utilization of Electrical Energy in the Plant*

BY WILLIAM FREDERICK

Presents the importance of stopping the multitude of apparently insignificant leaks which are apt to develop in a plant, particularly under the stress of rapid expansion, in order to promote the conservation of fuel. Points out a number of sources of possible loss throughout the plant and suggests means of correcting or avoiding them.

THE need for conserving fuel, particularly coal, is too well known to require reiteration. What does need to have emphasis placed upon it, however, is the fact that fuel conservation is not confined to its economical use under the boiler nor to the most approved methods of using the steam produced. So much of the mechanical power utilized by plants of all kinds is transmitted from the steam engine or turbine to its point of application by means of electricity that a consideration of the economies which can be introduced in its transfer and use are of great importance. They will often be found to be small ones; in fact, it is the small leak which is apt to go on unnoticed the longest. Even when we are aware of its presence, we are prone to ignore it in the press of more urgent matters. The importance of the small saving cannot, however, be overestimated. We have recently had splendid illustrations of the magic possibilities of accumulating huge totals through a multitude of insignificant contributions. The same holds true of small savings in power; the total of many will appreciably reduce the demand on the coal pile, although each one of itself may appear to be too

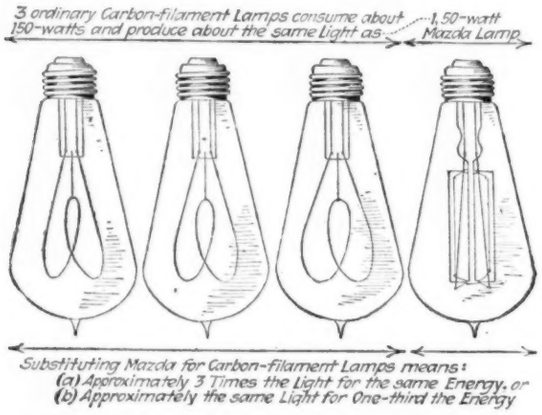

3 ordinary Carbon-filament Lamps consume about 150-watts and produce about the same Light as
1,50-watt Mazda Lamp
Substituting Mazda for Carbon-filament Lamps means:
(a) Approximately 3 Times the Light for the same Energy, or
(b) Approximately the same Light for One-third the Energy

FIG. 1. GRAPHICAL COMPARISON OF THE EFFICIENCY OF OLD AND MODERN LAMPS FOR SHOP USE

minute to matter. It is therefore the duty of the electrical staff of the plant to ferret out every such loss and to apply the remedy required.

The problem in electrical power saving begins at the generator. Fortunately, apparatus of this kind has reached a high degree of efficiency and is therefore not a cause for concern. What should, however, be considered is the size of the generating unit compared with the demand upon it. The use of a unit that is too large or too small for the load served and that, in consequence, operates at an excessively low efficiency for long intervals of time, is as surely a drain upon the fuel resources as if the current were being wasted in useless illumina- or useless plant operation. However, this a matter of first installation and in a well-designed power plant the conditions have been met as efficiently as possible, and

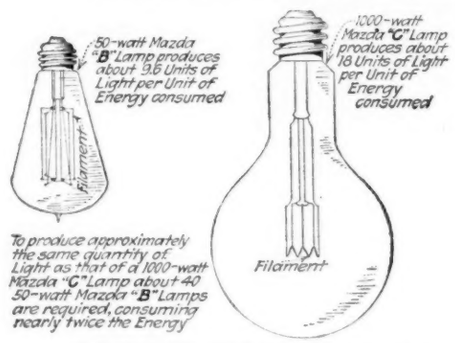

50-watt Mazda "B" Lamp produces about 9.6 Units of Light per Unit of Energy consumed
Filament
1000-watt Mazda "C" Lamp produces about 18 Units of Light per Unit of Energy consumed
To produce approximately the same quantity of Light as that of a 1000-watt Mazda "C" Lamp about 40 50-watt Mazda "B" Lamps are required, consuming nearly twice the Energy
Filament

FIG. 2. COMPARATIVE EFFICIENCY OF SMALL AND LARGE MAZDA LAMPS

even in those cases that leave something to be desired, it might be a matter of great expense to correct the situation and would, perhaps, not be justified from an economic standpoint unless the conditions were abnormal.

Beginning at the switchboard, however, many economies can be instituted at but slight expense and in many cases without expense at all. One source of loss that is frequently lost sight of is that which occurs in the service wires themselves. We become so used to the thought that feed wires have an inappreciable resistance that it is difficult to realize the magnitude of the loss that occurs in them, particularly when they are of considerable length and when an increasingly great load is imposed upon them through increased plant production. Too often the size of the wire is determined solely by the underwriters' requirements without reference to the loss that will occur in it. When lights are served from the same mains as motors such a condition is not so likely to occur, or to endure if it does, since the drop in voltage and the flickering due to changes in voltage would call for correction of it. When motors alone are served, however, there may be a very material reduction in voltage without any noticeable indication thereof in their behavior. The relation between the cost of installing additional carrying capacity and the saving effected thereby is of course the controlling factor in deciding how far to cut down line losses, but if unfavorable conditions are suspected, they should at least be made the subject of investigation, and if they are found to exist their presence should be made known.

Being assured of the economical distribution of electrical energy the next problem to be considered is its economical use. Broadly, there are two uses to which electricity is put; namely, power and light. The former is furnished by motors and the latter by lamps. We

*Credit is due C. E. Clewell for several suggestions incorporated herein.

therefore have to consider these two general classes of apparatus and their application to the existing conditions.

Motors are of various types, and of course the first duty is to determine that the one used is of the correct kind and also of the proper size. In addition to this the starting and regulating devices should receive careful attention. The applications of motors in the plant may be divided into two classes—individual drive and collective drive. In the former case the motor drives a single piece of apparatus, and in the latter it is connected to a lineshaft or other such means of supplying power to a number of different loads. The individual drive is theoretically the preferable one, but of course many elements enter into the question from a practical view. These are the general aspects of the motor situation, and a survey of them should be made from time to time for the purpose of making recommendations looking to the more economical use of the power available. There is such a diversity of applications and there are so many individual problems involved that in the very nature of things no specific suggestions can be made in reference to them. However, there are a number of precautions which are of general application to all kinds of motor drive, some of which are set forth in what follows.

Among the losses in motors are friction of bearings and brushes. Care should be exercised in keeping this loss as small as possible. Bearings should be given careful attention and brush spring pressure should be reduced to the lowest point consistent with satisfactory operation of the machine. In the case of belt drives there should be a minimum of slip, geared drives should be kept well lubricated and badly worn gears replaced; in direct drives the alignment should be given attention. When not being used, motors should be shut down and not be allowed to run idle. To encourage economy in this direction, it is the part of wisdom to install control apparatus at convenient locations. Two objects are gained thereby—the operator is induced to practice economy, and a saving of his time in reaching

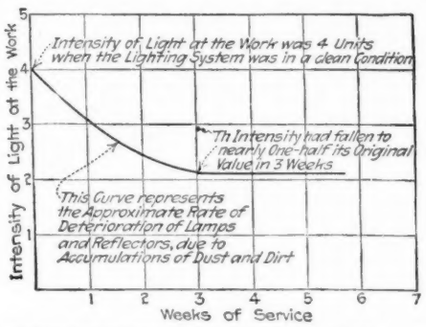

Intensity of Light at the Work
Intensity of Light at the Work was 4 Units when the Lighting System was in a clean Condition
Th Intensity had fallen to nearly One-half its Original Value in 3 Weeks
This Curve represents the Approximate Rate of Deterioration of Lamps and Reflectors, due to Accumulations of Dust and Dirt
Weeks of Service
1
2
3
4
5
6
7

FIG. 3. CURVE SHOWING DETERIORATION WHICH MAY OCCUR IN LIGHTING EQUIPMENT, DUE TO DUST AND DIRT ACCUMULATIONS IN THE SHOP

the point of control is effected. However, it is not economical to shut down a large motor for only a few moments. The energy and time used in starting it again will more than counterbalance the saving during the interval of shutdown.

Wasteful methods of speed control should be eliminated. For example, for direct-current shunt-motor operation requiring adjustable speed, interpole machines should be used, the speed control of which can be accomplished by means of field-current regulation, in preference to the old type of straight shunt motor requiring resistance in the armature circuit, which is a method very wasteful of energy, especially when a wide range of speed regulation is necessary. Moreover, the superior speed regulation of the interpole motor at

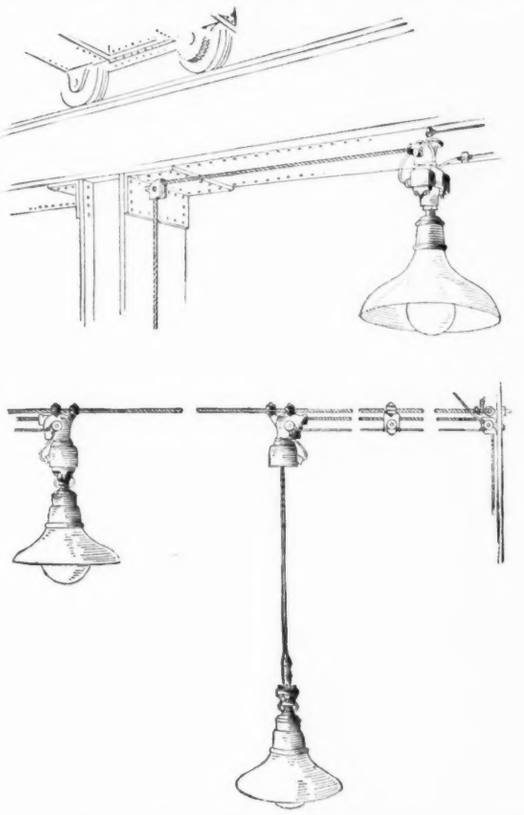


FIG. 4. ARRANGEMENT AND OPERATION OF A THOMSON DISCONNECTING HANGER ADAPTED FOR SHOP USE

each step of its speed leaves little excuse for the retention of the old type of machine for adjustable-speed service.

In the case of alternating-current motors requiring frequent starting, it is preferable to use a transformer type of starter rather than a resistance type, since the loss in the latter far exceeds that in the former. The manner of starting motors can also be made the subject of economy, especially in large sizes, and it is an argument for the installation of automatic starters wherever possible. Dynamic braking is another means of economy which should be employed where conditions permit its use.

The other use to which electrical energy is put—namely, lighting—offers even a wider field for economy on the part of the individual than is usual with power applications. While the amount of energy involved is small in comparison with power demands, the multiplicity of occasions on which savings can be effected is such that the total will compare very favorably with the power economies. For example, no one would consider allowing a 10-hp. motor to run idle for hours at a time, and yet less power would be wasted thereby than by allowing twenty 50-watt lamps to burn uselessly.

A regard for economy in this direction can be fostered by placing the controlling switches in readily accessible locations, as in the case of motor-controlling devices

Moreover, if group lighting is in use, there should be only a limited number of lamps on each switch, in order that the lighting may always be subdivided to meet the requirements. Thus, a room of some depth may receive sufficient daylight under the normal condition, but may require artificial illumination in the parts farthest removed from windows when the day is dull. It should be possible to turn on lamps in this section without at the same time turning on those in the sections that remain well lighted from the outside.

The type of lamp used, the style of reflector and the maintenance of both the lamp and its reflector are matters of particular interest. Bound up with the efficiency of the lighting system is its effect upon production. Better lighting usually means greater production, less wasted effort, less irritation to nerves. Probably few things lead to greater inefficiency than the physical discomforts of lack of proper heating and lighting, and the nervous strain due to the latter cause is none the less real because it is generally not apparent. By better lighting is not necessarily meant more light. Oftentimes a reduction in illumination is actually de-

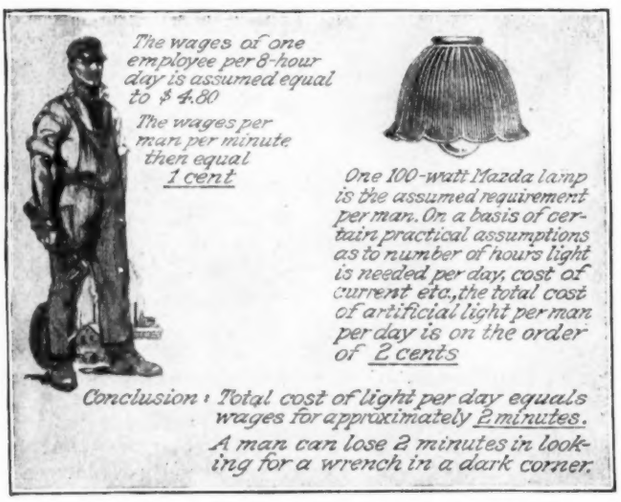

The wages of one employee per 8-hour day is assumed equal to $ 4.80
The wages per man per minute then equal 1 cent
One 100-watt Mazda lamp is the assumed requirement per man. On a basis of certain practical assumptions as to number of hours light is needed per day, cost of current etc., the total cost of artificial light per man per day is on the order of 2 cents
Conclusion: Total cost of light per day equals wages for approximately 2 minutes.
A man can lose 2 minutes in looking for a wrench in a dark corner.

FIG. 5. COMPARISON BETWEEN LIGHTING COSTS AND LABOR IN THE AVERAGE SHOP

sirable. The apparent inefficiency of indirect lighting systems is in reality a gain, in that the rate of production is stimulated by the greater comfort of proper illumination. We do not primarily wish to obtain the greatest candlepower per square foot of floor surface for the consumption of a given quantity of coal; what we desire is the greatest output of product for that amount of coal. Thus, while it seems irrational at first sight to develop a lamp of high efficiency and then deliberately to divert its lighting power to such an extent that the final illumination obtained is only a fraction of that utilized, the results will be found to justify the means.

While the laying out of a comprehensive system of lighting may require the services of an illumination engineer just as the laying out of the power installation would require those of a power engineer, yet the man about the plant can inaugurate many economies on his own initiative, and can, moreover, add greatly to the efficiency of any existing installation by systematic inspection and maintenance of it.

The first point to be observed is that only high-efficiency lamps should be used. There is today practically no excuse for the use of carbon filament lamps on circuits that utilize coal-made current. A 50-watt metallic filament lamp using 1.1 watts per candlepower gives an illumination of about 45 cp., in comparison with which a 16-cp. carbon filament lamp at 3.1 watts per candlepower requires an input of about 50 watts. That is, for a consumption of the same amount of energy we get about three times the illumination from the metallic filament, or "Mazda," lamp, that we do from the carbon filament one. This can be shown very strikingly by such a comparison as that made in Fig. 1, in which the ratio is shown by the relative numbers of lamps used.

Next in importance to the use of high-efficiency lamps, is the selection of the correct size of the unit, and following that the best type of reflector or shade to be used. For individual use great brilliancy is objectionable and a 50-watt lamp is more than ample. For general lighting the size of lamps will be determined by the distribution required and the height of ceiling. Conditions being suitable, it is preferable to use one large unit in place of several smaller ones, since the efficiency of the large gas-filled lamps far exceeds that of the small Mazda lamp. Thus, one 1000-watt lamp will produce approximately the same illumination as forty 50-watt lamps using twice as much energy, as illustrated in Fig. 2. However, a lamp of this size can be used only under exceptional circumstances and should not be employed without a thorough understanding of the principles involved. On the other hand, it is a matter of comparative simplicity to select a shade or reflector most suitable to the requirements. For general illumination glass shades can be used to advantage if their position does not expose them to breakage. The manufacturers of such shades issue detailed information regarding the direction given to the light from the lamp by the various types of shades, and the one to be selected is, of course, that which throws the light where it is most wanted.

There is slight object in installing a highly efficient lighting system if its upkeep is not a matter of constant care. Two things are to be observed in reference to it—lamps must be renewed when their useful life has been spent, and above all, lamps and reflectors must be kept clean. To emphasize the importance of this latter point reference is made to Fig. 3, which shows by means of a curve, the deterioration that took place in a lighting system within a period of a few weeks, due to failure to clean the lamps and fixtures. As will be seen, the illumination had decreased almost 50 per cent. at the end of three weeks, owing to this cause. It is, consequently, a matter of great importance to systematically look after the equipment, and to arrange it in such a manner that it can readily be reached.

Where lamps are situated at considerable heights, some such device as that illustrated in Fig. 4 should be used to make them accessible.

While it is desirable, in fact, necessary, to have sufficient light where light is required, there are many parts of a plant that require only a very small amount of general illumination and in which lavish lighting provision would be a waste. On the other hand, curtailment of illumination should not be carried to the other extreme. An operative's time is far more valuable than

the equivalent of the light that he requires, and it is false economy to allow conditions that in any way interfere with the most profitable use of his time or labor. In Fig. 5 is presented a comparison showing that lighting provision per man in an average plant will be in the neighborhood of two cents per day, whereas his wages will amount to about one cent per minute. It would therefore require a loss of only about two minutes of his time to wipe out what could be saved by failing to provide him with adequate illumination.

Each plant will present its own problems, but in each one diligent search will generally unearth many sources of slight waste. In applying remedies, it is of course necessary to use judgment; the plant must produce more material for the same coal consumption or use less coal for the same production rate.

The Power Situation at the End of the War

By L. W. ALWYN-SCHMIDT

The author summarizes the power situation that has resulted from the upheaval of war and points to a greatly increased use of power in industry in the future.

MODERN industrial enterprise cannot exist without power. Considering this fact it seems that our existing means of providing this essential adjunct to all industrial production are pitifully small. There are today only three recognized creators of industrial power—fuel, water and wind—not a very imposing number to fall back upon, especially as little use is made of the third.

The war has overthrown our complacency. It has shown us that the principles of our power economy are faulty, not to say wrong, and that the system under which we are working is not reliable and will break down if exposed to any great stress. We had an example of this when many of our national industries had to shut down for a series of Mondays because sufficient coal could not be provided to keep their boilers going. We had another example when a million automobiles were laid up for several Sundays because sufficient gasoline was not available.

Distribution of Coal to Power Houses

The distribution of coal from the mines to the power houses has not been solved satisfactorily. The problem today is the same as it was five years ago. Nevertheless, the war has taught not only the nations but also the individual power producer that coal is not absolutely reliable as a generator for industrial energy. The principal deficiency in the case of coal is its limitation in production. Coal is mined in comparatively few localities, and the necessity of bringing it to the places where it is consumed forms a permanent burden on the transportation facilities of the world. An interruption of these facilities threatens an immediate breakdown of industrial production. There are many countries that have very little coal of their own, or coal of very inferior quality, and that depend for the upkeep of their industrial life on the good will of other countries. Their industry may be completely strangled if these countries should decide to stop supplying coal. What is said here with reference to coal applies more or less to oil and coal gas also.

While the war has not provided a solution of the various problems created by the use of coal for power production, it has at least set many minds to work to find a way out of the present difficulty. Two proposals have been made. The first is to stop shipping coal for power production, to produce the power on the spot where the coal is found and to transmit the power. The second is to limit the use of coal as much as possible and to use other more convenient forms of power production, as, for instance, water and wind. As an immediate means of bringing relief a more economical use of coal has been advised.

The latter proposal may be considered here in the first place, not only because it has been applied with great success during the war, but also because conservation will be a considerable factor in after-war power production until more thorough changes in power production and conservation can be effected.

Coal-Conservation Work in Italy

The most thorough work with regard to coal conservation probably was done in Italy. The Italian industry has had to battle with the coal problem from the first days of the war, even before it had entered the struggle. The lignite produced in Italy is of small steam value and nearly all industrial fuel is imported. When it became clear that Italy would have to face a serious fuel crisis, the Italian government had a survey made of its power facilities with a view to establishing the number and character of boilers that would be available for power production, and what might be their efficiencies with different fuels. Especial attention was given to the question of burning native coal. Power engineers all over the country were advised to exercise great care in the use of coal and to avoid all waste of power. The result was that Italy obtained a greatly increased industrial production with a vastly decreased supply of imported coal. In France similar good results have been obtained.

Improvements in Economy Likely to Continue

There has possibly never so much been written on fuel conservation, power economy and similar subjects as during the last four years. American writings alone would fill a good-sized library. Each contribution to the solution of the great problem of how to get maximum power with the use of the smallest amount of coal has advanced us a step farther. Statistics show that many factories have reduced their coal consumption by more than 10 per cent. We may possibly relax in our vigilance, but it seems improbable that our improvements will be lost again. It is much more likely that improvements, once introduced, will continue. One of the results of the war will be that fewer railroad cars will be wasted in future and that less coal will be required by those establishments which will continue to burn coal.

The idea of centralizing the production of power in certain favored neighborhoods and distributing it to consumers has claimed wide attention in England. A British governmental committee of engineers has worked out a plan by which it is proposed to erect a series of large central stations in certain suitable cities and to connect these stations with substations in other cities for the distribution of power to the consumers. The principal producing stations will be interconnected in such a way as to guarantee a permanent supply of power to all consumers even if one of the stations should break down. The English plan provides for the use of coal only. The cities that have been elected for the localization of the principal stations are conveniently situated in proximity to coal fields, and coal, therefore, will be always available at cheap rates.

Centralizing the Production of Power in Germany and France

A similar proposal was made in Germany and in part at least was carried out during the war. The German plan, however, goes a step farther than the English, because it proposes not only the use of coal as a producer of the required electrical energy, but use will be made also of certain water powers. The scheme provides for a series of central stations in coal fields with hydro-electric stations on lakes and rivers, and the general idea seems to be to arrange the individual stations in triangles. Two hydro-electric stations always will have the support of one steam-generating station, the three supplementing one another. Finally, all the stations will be interconnected. Power from part of the new system is already being transmitted over distances which in some cases exceed a hundred miles.

A similar proposition has been made in France, and it is also intended to arrange on the coöperative plan the new central-station system which will replace the stations destroyed by the Germans. The present plan provides in the French northeastern coal fields a number of big power stations that will distribute power not only to the immediate neighborhood but most likely also to Paris.

Power Stations in the Coal Fields

The system of placing electric power stations in the coal fields, while it appeals to the imagination of the engineer, has certain economic disadvantages that in later years may lead to actual difficulties. One of these is that the electrical power produced in this way is unreasonably expensive in the immediate neighborhood of the central station. Experience has shown that large industrial enterprises in the vicinity of coal fields are not very good customers for central stations in the same districts for the simple reason that they can produce their own electric power cheaper than the central station will sell it.

The big industrial enterprises in proximity to the coal fields can obtain coal without straining unnecessarily the national means of transportation, and if they choose to make their own electrical energy, more of the central-station power will be left for distribution to the farther removed districts. But there is an economic limit to the distribution of coal-generated electrical energy. Eventually. a distance is reached at which distribution of energy either is impossible owing to technical reasons or becomes too expensive in comparison with other means of producing power. It may in such instances even be cheaper to ship coal than to transmit electrical energy.

World-Wide Increase in Application of Hydro-Electric Power

The outstanding feature of power development during the war is the rapid expansion of the application of hydro-electric power all over the world. There is not a country that has not given attention to the question of how to make better use of its dormant water power by turning it into electrical energy. Norway, doubtless, has led the way in this respect. Thousands and thousands of horsepower have been harnessed during the last four years and this country has carried out a power scheme the foundations of which were laid before the war. Norway in this respect has been favored very much by the mountainous character of the country, the many waterfalls of which seem to supply what amounts to a practically inexhaustible supply of natural power.

Italy has been able to supplement its existing power supply by an increasing recourse to natural power derived principally from the waterfalls of the southern decline of the Alps and the Apennines. The Alps most likely will play a considerable part in the future by supplying Europe with electrical energy. Switzerland will soon be the owner of a large system of interconnected hydro-electric stations, efforts are being made to harness the waterfalls of the French Alps, and Germany has in operation several hydro-electric stations, all built during the war, which draw their power from rivers fed by the snow mountains of the Alps. Another important center for hydro-electric developments in Europe is the Pyrenees. Several new hydro-electric stations have been added to those existing during the war, and France as well as Spain has prepared a number of projects which will make use of the waters of this mountain range.

Hydro-Electric Power Development in South America and Australia

In South America there is a great awakening to the necessity of making better use of natural resources. Parts of South America, as Venezuela, Colombia, Peru and Chile, offer conditions for hydro-electric development as favorable as those existing in Norway. These conditions are being studied by the governments and financial interests with a view to making use of them in the near future, while a number of projects have already been taken in hand or have been completed during the war. In Australia great work has been done by completing the Great Lake development in Tasmania and the Lake Coleridge development in New Zealand. Both schemes were finished under great difficulties, but the assistance they have rendered to the industrial development of their respective countries in a trying time has repaid a hundredfold the expense and labor incurred in their completion.

Public ownership has made considerable progress during the war. This has been partly the result of earlier policies, but just as much that of existing conditions. In some cases the original promoters were not able to carry out the work and the government was compelled in the public interest to complete the task. In others

necessity made imperative immediate construction which had to be carried out with public aid, as no private capital would undertake the work. Norway has used the opportunity to strengthen the power of public control over the natural resources of the country, and similar projects are now under consideration in other countries, including the United States.

Speaking in general terms it appears that the war has rather benefited the power industry. Its principal results so far are a tendency in the direction of greater centralization of power production, an increase in the use of water power for electrical development and an awakening of the national consciousness to the responsibility for the dormant natural-power resources in the possession of the nation. The war finally has taught us the great value of mechanical power as a preserver of human energy.

It is this final realization which will be the dominant factor in future power development. Having once recognized this inherent characteristic of mechanical power and its economic effectiveness, the world will not return to its pre-war methods of wasting human energy where it can be easily replaced by mechanical power. It also will not return to its pre-war practices of wasting power. The effect of all this will show soon in the general position taken by power users with reference to the methods employed in the production of power. The old-time engineer, the happy-go-lucky chief, will be a man of the past. He has not been driven out, but the hard time he has gone through has changed the man and his method. Factory owners and power users suddenly have come to the realization that their power supply is not a thing to be taken for granted, but that it is subject to the same economic laws as all other forms of industrial production and that it has to be handled efficiently if it is to produce efficient results.

There will be more power used in future than has been used in the past. Europe must replace by an increasing recourse to mechanical power the energy of many millions of men who were killed during the war. It also has to make up for the loss of efficiency in the crippled who will again take part in industrial production.

We in our own country will have to make use of additional power to keep our industrial production at a level that will enable us to compete with the cheaper European goods so that we may hold our present position in the world's markets.

Rejuvenating a Worn-Out Pump

By H. H. HUNNER*

A SINGLE-STAGE pump making 1750 r.p.m. and pumping 1290 gal. per min. on a 165-ft. head was found to lose its water once or twice in 24 hours whenever the power-line voltage fluctuated to a point low enough to cause it to drop in speed, and when running, the pump would pound with a continual end thrust. On examination it was found that the ring seats were worn away on both sides of the impeller and that the recess in the castings which accommodated the rings was gouged out on both sides, top and bottom. The sides of the casing next to the impeller were worn in places to a depth of over half an inch.

To repair the impeller, the ring seats were turned down to make a driving fit for two rings that had been previously made up. A ¾-in. section was cut from these rings, the ends were drawn up and welded, and, after having been driven to a tight fit on the new seats cut on the impeller, they were turned down to give a running fit for the standard rings, which made an impeller as good as new.

The repair of the castings required two barrels of charcoal, 40 ft. of 42-in. asbestos paper, 75 firebrick, 150 cu.ft. of oxygen and 12 carbic cakes. An air line was extended to the place where the castings were to be heated, and five feet of 1-in. pipe was used for a nozzle to produce forced draft. The castings were stood on end on the ground, propped up with firebrick and walled in on all sides with the firebrick placed about 18 in. away from the castings, the brick being laid with about ½-in. spaces end to end.

The brick wall was built up to the height of the castings, and the charcoal then dumped in between the brick and castings on a kindling-wood fire. The top of the castings and the charcoal was then covered with two thicknesses of asbestos paper, cut into 42-in. square sheets; the air, turned down to about 10-lb. pressure, was used to give the charcoal a good start, and the improvised furnace was left for three hours without artificial draft, after the charcoal had a start. On removing enough brick to reach the ring recesses, it was found that the castings were easily brought up to a welding heat on applying the torch for a few seconds.

Both castings were repaired on one side, and the brick wall was torn down, using forceps to handle the bricks. The castings were flopped, the charcoal was heaped around their base, and the bricks were built up to hold the charcoal in place. By covering the entire work with asbestos paper, the operator was able to work at close range without undue exposure to the heat. When the time arrived to fill in the last piece of casting, it had cooled too much to work without reheating. The supply of charcoal was exhausted, but pine wood was available, and the bricks were covered with sheet iron and the air nozzle was used again, and this combination secured a better heat in an hour's time than had been possible by means of the charcoal, which is not essential where air is available.

The operation was finished in about eight hours, and little hammer and chisel work was required to get a smooth job on the castings. At a moderate expense a new water end was provided, and a wait of six months for delivery on a unit that was absolutely essential was obviated.

The castings were covered with the asbestos paper after the job was finished and allowed to cool slowly for several hours.

*Superintendent Onahmon Iron Co., Ironton, Minn., in *Engineering and Mining Journal.*

Coal-Handling Plant at Sewalls Point, Virginia*

New facilities of the Virginian Railway at the coal pier near Norfolk, Va. The plant also includes cars of 120 tons capacity and a long incline.

A DOUBLE car dumper, with pier cars of 120 tons capacity and an elevator to raise them to the top of the pier, have been added to the facilities of the coal pier of the Virginian Ry. at Sewalls Point, near Norfolk, Va. They supplement a single dumper, pier cars of 60 tons capacity and a barney incline from the dumper to the top of the pier, installed in 1909, when the pier was built, and increase the capacity of the plant from 1500 tons per hour to 3000. The operation of the pier is the same as before, the pier cars for both dumpers running out to the end of the pier by electric power on the outside track and returning down the inclined center track.

The double car dumper is the first built to overturn two ordinary road cars at a time. It is 94 ft. long between end posts. The car rails are carried on a movable platen which rests on rollers in the bottom of the cradle —or, in fact, two platens, end to end, one for each car. When the cars are on the dumper, the platens are moved laterally until the sides of the cars come securely against the side of the cradle for support. When the two cars are of about the same width, it is not necessary to uncouple them, but when they are of different widths the two parts of the platen can be operated separately. Eight clamps are operated independently by counterweights which travel in guides at the rear of the machine. They are so spaced that they engage various lengths of cars and are automatically adjustable to any height or width of standard railway car.

Rotating Machinery Top of Main Structure

The machinery for rotating the cradle is located on top of the main structure, where it is free from dust and accessible for repairs. After the cars have been properly placed on the cradle, the rotating mechanism is started and the cradle with the cars is revolved until the cars are inverted to an angle of 20 deg. with the vertical. The clamps as well as the cradle are counterweighted, this facilitating the return of the cradle to its former position.

Coal dumped from two cars end to end is distributed over a maximum length of about 88 ft. This is much greater than could be gathered in the hopper of a transfer car, which in this case is about 51 ft. In order that all the coal from the road cars shall be properly discharged into the transfer cars without resort to a concentrating chute, which would at once result in an extreme drop of the coal, two steel apron conveyors are provided, each about 8 ft. wide and 34 ft. long, supported horizontally in a portal frame in front of the car dumper. A clear space of about 36 ft. is left between the conveyors, which form a portion of the bottom of a hopper into which the road cars are dumped. The longitudinal center of the conveyor is located directly over the center line of the transfer-car track. With this arrangement all the coal that falls on the conveyors is transferred horizontally and discharged into the transfer cars.

Two 275-hp. motors, designed to work on a direct current of 550 volts, operate the cradle working through four drums geared by three reductions of cut spur gears.

As the cradle is rotated the contents of the car is gradually discharged over the edge of the apron plate, into the receiving hopper which carries the conveyors. This hopper, for a distance of 36 ft., is open at the bottom, and the coal is discharged directly through it into the transfer cars. The conveyors are interlocked with the cradle, so that when the rotation starts the conveyor motor is also started, and the conveyors are in full operation when the first coal falls on them. They are both operated by one 80-hp. motor.

The Disappearing Barney

A disappearing barney, which on the return trip, when near the bottom of the incline, follows a low-level track into the barney pit so that cars can be let down by gravity from the load yard before the barney is in position, pushes the road cars up to the dumper. Both the barney and the dumper are operated from a cab at the incoming end of the dumper. All of the speeds and the motions of the dumper are regulated to produce a complete cycle in two minutes.

The dumper will handle at once two cars of 60 tons capacity, or one of the new 110-ton hopper cars of the Virginian, which weighs 160 tons when loaded.

Transfer cars of 120 tons capacity—just double that of those originally installed on the pier—take the coal from the dumper. These cars are mounted on two six-wheeled equalizer trucks, each of which is provided with a driving motor of 60-hp. capacity, geared for a speed of 12 miles per hour.

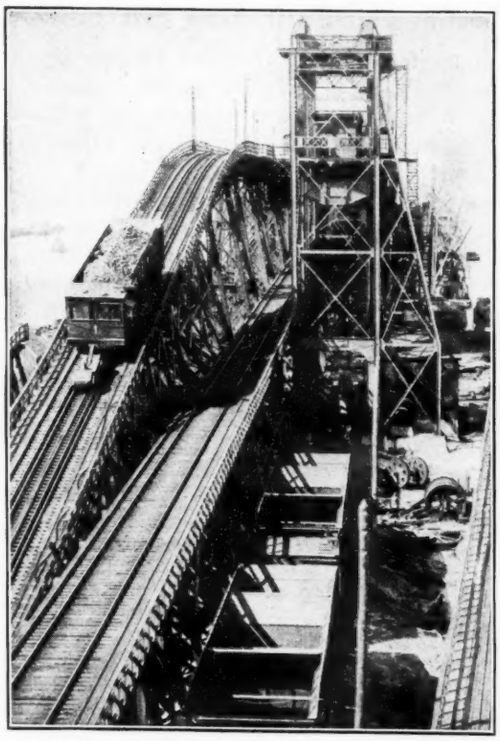
The trucks are spaced 50 ft. center to center under the car, the total over-all length of which is about 70 ft., the height 16 ft., and the width 12 ft. The body of the car forms a hopper divided into three compartments, each having a capacity of 40 tons, the three compartments having a combined length at the top of about 51 ft. Each of the compartments is provided with a double system of discharge gates at the bottom, through which the coal passes into the pockets to the pier. The gates of each compartment are separately operated by an air cylinder located in the end of the car.

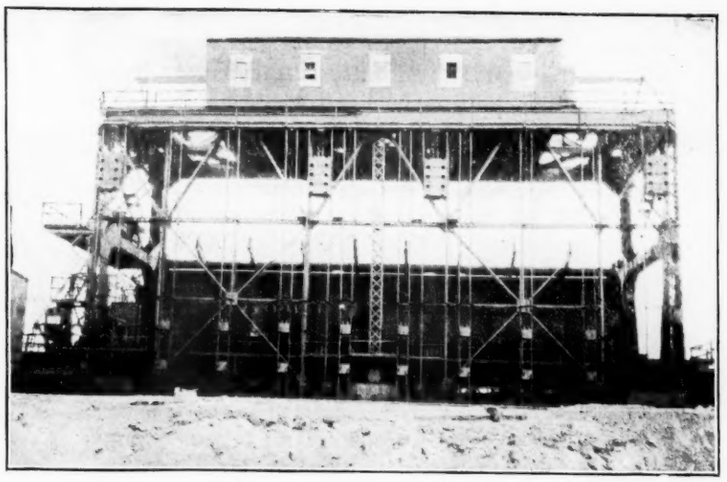
Discharge Gates Arranged in Pairs

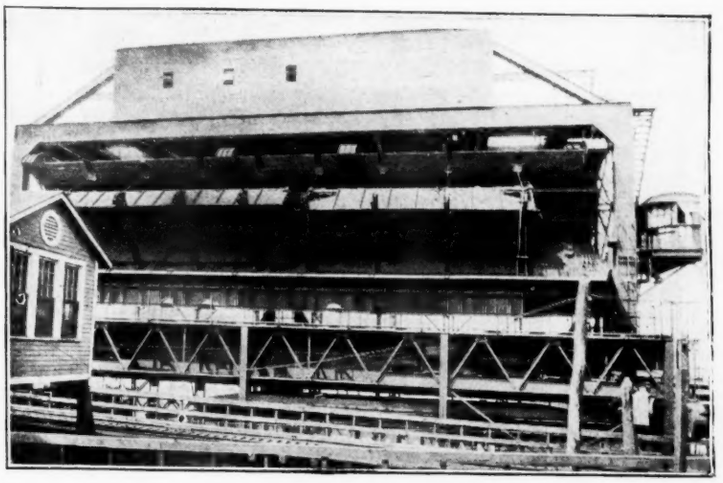
The discharge gates of each compartment are arranged in pairs and hinged to the car body at the sides and in the center, in such a manner as to provide two openings 9 ft. long by 3 ft. 8 in. wide. The operating mechanism is so arranged that the gates are securely locked when closed, and they cannot fall open.

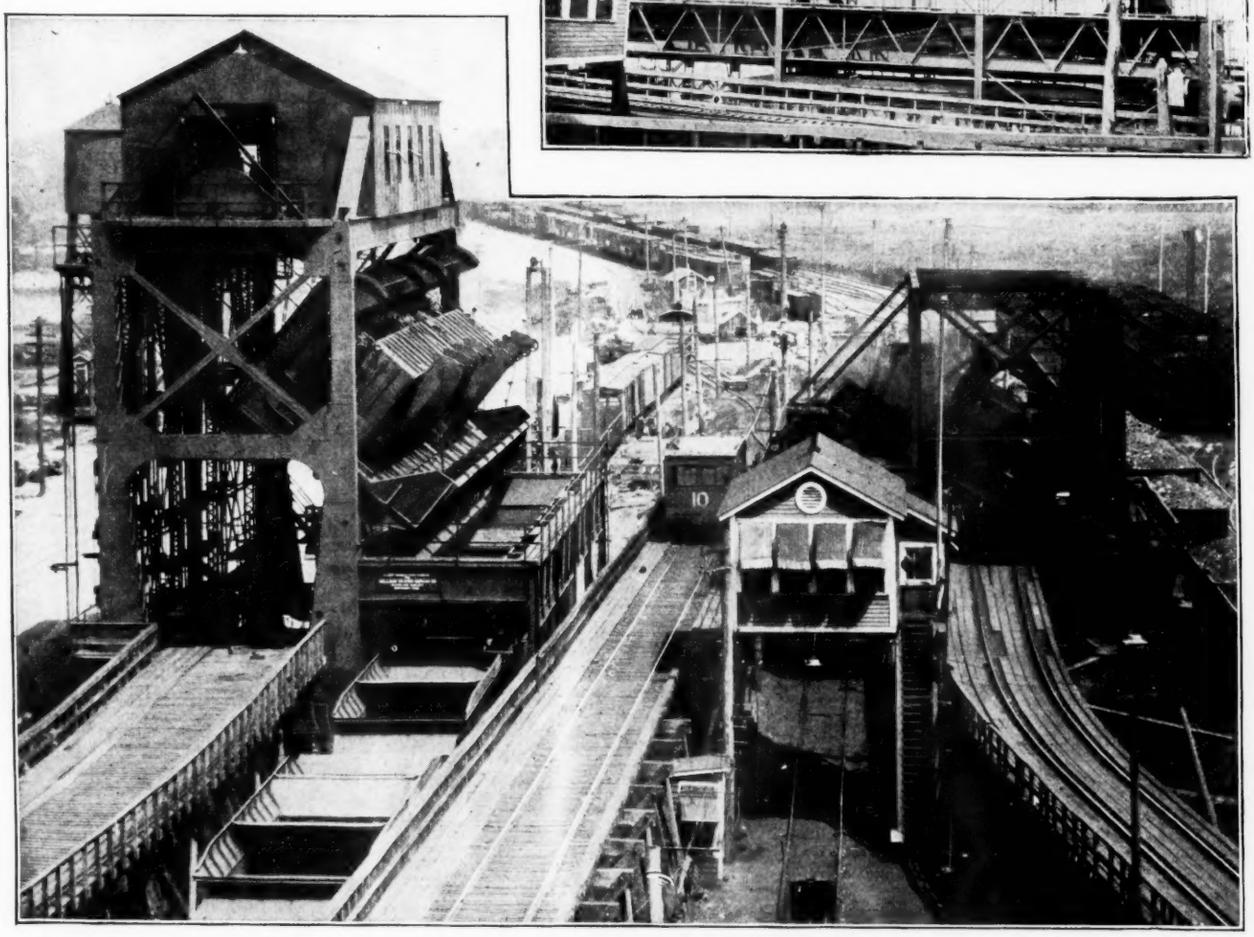
All operations are controlled from one end, although each end is inclosed. The power for operating the cars is supplied from an overhead catenary system. The combined weight of the car and its contents is about

*From *Coal Age*









TWO GENERAL VIEWS SHOWING OLD AND NEW FACILITIES SIDE BY SIDE, AND TWO VIEWS OF NEW DUMPER HANDLING TWO ORDINARY ROAD CARS AT ONCE

200 tons, making the cars the largest coal-transfer cars ever built.

The transfer-car elevator raises the pier cars about 67 ft. to the top of the pier. Heavy counterweights are used to counterbalance the weight of the platform and the car; they are so regulated that as much power is required to pull down the empty platform as is required to lift the platform and the loaded car. This arrangement permits the use of smaller motors than would otherwise be necessary.

The elevator is operated by two 450-lb. motors using a direct current at 550 volts. The gearing of the elevator is proportioned to produce a complete cycle in two minutes.

Connecting the frame of the elevator to the pier is a hinged run-off girder, introduced to insure perfect alignment of the rails on the platform and the pier. This girder is hinged to the pier in such a manner as to permit of a vertical movement of the free end amounting to about two feet. The free end of the girder rests on brackets on the elevator frame, from which it is lifted by projecting lugs on the platform as it comes to the position of its upper limit. This upper limit of travel is accurately controlled by an electric limit switch, geared to the hoisting mechanism. The power is supplied to the trolley wires in this position, and the transfer car passes out of the elevator, over the hinged run-off girder and out on the pier, where the coal is discharged to the proper pocket. The empty car then returns down the inclined track in the center of the pier structure to the loading track in front of the car dumper, taking its regular turn.

These additions to the equipment of the terminal were installed by the Wellman-Seaver-Morgan Co., Cleveland, which company furnished the original dumper. The work was carried out under direction of H. Fernstrom, chief engineer of the Virginian Railway.

Standard Boilers for Emergency Fleet

The standard water-tube boilers for the 3500-ton vessels of the United States Emergency Fleet, says the *Boiler Maker,* are of the cross-drum type, having straight tubes expanded into steel headers. Their widths are 13 ft. 4⅞ in.; heights to the center of the steam drum, 11 ft. 5½ in.; depth, 8 ft. 10 in. The total heating surface is 2544 sq.ft. The grate is 6 ft. 6 in. long by 11 ft. 9 in. wide; area, 77.45 sq.ft.; the ratio of heating surface to the grate area being 33 to 1. The boilers are made for 200 lb. gage pressure, and output, under forced draft, of 15,000 lb. of water per hour, with feed water at 203 deg. F., and a combustion rate of 20 lb. of coal per square foot of grate per hour.

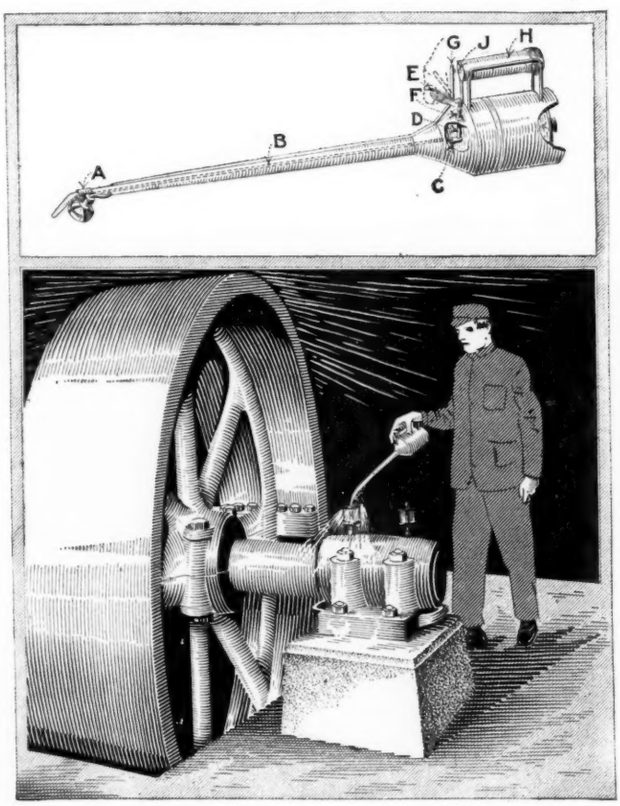
It has been proposed as a matter of great importance to the business of the country that the functions of the Bureau of Standards should be extended to permit the maker of any standard article to submit samples for examination and test, the Bureau, after such test, to certify to all the facts and findings respecting the nature and quality of the article, so that buyers, domestic or foreign, may come to a knowledge thereof and govern themselves accordingly.

Bateman Illuminating Oil Can

An illuminating oil can, intended for use by engineers where the parts to be lubricated are in dark places or for use at night, has been patented by William G. Bateman, 154 Lackawanna Ave., East Stroudsburg, Penn.

The can is of ordinary shape, but the nozzle is fitted with a valve *A* to which is attached a stem *B*, which connects with an arm *C* on a rod *D*. This rod projects to the outside of the can and has a handle *E* on its outer end. A spring *F* closes the valve when pressure on the handle is removed.

Attached to the end of the spout is a lamp socket and lamp. One terminal of the socket is connected to



DETAILS OF CAN AND ITS APPLICATION

the spout of the can, the other terminal is wired to the hinged contact arm *G*, the wire being protected by a duct. In the handle of the can a dry battery *H* is carried, with one terminal grounded to the can. When the lever is pressed down it comes in contact with the hinged arm *G*, which closes the circuit with the contact *J*. When it is not necessary to illuminate the parts to be oiled, the hinged lever can be turned back and the valve in the spout manipulated by pressing on the lever *E* the same as when the lamp is used.

With firmness in the right, as God gives us to see the right, let us strive on to finish the work we are in; to bind up the nation's wounds; to care for him who shall have borne the battle, and for his widow, and his orphan—to do all which may achieve and cherish a just and lasting peace among ourselves, and with all nations.—*Abraham Lincoln.*

Combustion and Boiler Settings—I*

By A. D. WILLIAMS

The author mentions a number of interesting points concerning the location of heating surfaces, the placing of baffles and the formation of soot in relation to combustion, and indicates certain fundamentally wrong practices in the usual forms of boiler settings.

A GREAT deal of thought has been expended upon the baffling of steam boilers to obtain increased gas velocities and thereby an increased rate of heat transfer. However, there is a disadvantage in a high velocity, as the velocity head increases as the square of the velocity, and in addition there is an increase in the friction loss. The heated gases will also have less time in which to deliver their heat to the recipient surface.

With an infinite increase in velocity and a finite heating surface, the hot gases would sweep past at such a rate that the heat-transfer rate would be reduced to an infinitesimally small value and the gases would leave the recipient surface at practically their initial temperature. On the other hand, with an infinite reduction in the gas velocity the gases would lose practically their entire heat content, but the rate of heat transfer would be infinitesimally small, as before. Between these two extremes lies the desired case in which the quantity of heated gas sweeping over the recipient surface gives up the maximum amount of heat that the surface is able to absorb, between the temperature limits fixed by the heat generated by combustion and the ruling temperature of the recipient surface. In practice this problem is complicated by the surface condition of the recipient surface and the vapor tension of the hot gases.

Heat transfer is entirely a physical problem, considered by itself. Combustion is a chemical problem. In considering the industrial applications of heat, the chemical and physical exchanges and reactions must be considered together as well as separately.

Conditions That Affect Reactions

In combustion for industrial heating the speed of the reaction depends on the intimate mixing of the reacting substances at a temperature and pressure, with a sufficient mass of the reacting substances present to permit the reaction to be self-propagating. Changes in pressure, temperature and the concentration of the reacting substances all affect the rate of the reaction and the equilibrium of the reacting system.

There are three typical combustion conditions, as follows:

1. Neutral, in which the reacting substances are present in sufficient concentration only to complete the reaction. In this case combustion will be slow, the reaction starting at a maximum rate and gradually slowing down.

2. Reducing, in which there is a deficient supply of the oxidizing or reducing element. This condition is typified by the gas producer, the blast furnace and the combustion in the fuel layer of any fire.

3. Oxidizing, in which there is an excess of the oxidizing or reducing element present.

In connection with a boiler all three of these conditions exist at different zones and each zone may occupy an appreciable space; that is, there is an appreciable time factor in the reactions. Industrial heating would not be possible without the time factor, for as the time factor becomes smaller and smaller the intensity of the reaction becomes greater and greater as its velocity increases and it finally attains explosive violence. Such combustion, while desirable in the case of a high-explosive shell, would be difficult to utilize in a furnace.

Enough Air Cannot Be Forced Through Fuel Bed

Recent experiments[1] show that the fuel bed of a furnace fired with solid fuel acts as a gas producer; that it is impossible to force through the burning bed of fuel an air supply sufficient for complete combustion; that increasing the air pressure below the grate simply results in an increase of the unit rate of combustion of the fuel and that in all cases there is a large content of combustible with no comburent (reducing element) in the gases leaving the fuel bed; and that it is absolutely necessary to introduce additional air above the fuel bed to complete combustion.

Roughly, these experiments indicate that less than 50 per cent. of the air required for a solid fuel can be forced up through the burning fuel and that the remainder of the air supply must flow into the furnace in a different way, as, for example, (a) through unignited fuel, (b) through holes in the fire or (c) by being introduced over the fire. The first two of these methods are the ones commonly—and in many cases inadvertently—in use. They are difficult to control accurately. The third method has been used for many years in metallurgical work, though even in this field there was a misconception of the reason for so doing that has resulted in misdirected effort and poor design.

With gaseous fuel the mixing of the combustible and the comburent is more readily secured and in addition it is feasible to preheat either or both of these supplies and so increase the flame temperature, making it possible to obtain high temperatures. But even in this case, where the reducing and neutral zones of combustion are at a minimum, they still exist. It is possible that these zones are even present when the gas and the air are mixed outside the burner at a low temperature, as in this case the combustible and comburent must be raised to the ignition temperature before they can combine. The same is true for liquid or powdered fuel which must be jetted into the furnace.

With any fuel it is necessary that the flaming gases remain at a temperature above their ignition point until combustion is complete. The time required to complete reduction will depend on the degree of mixing obtained, and the distance the flaming gases travel in this time will depend on their velocity, this last being a function

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[1]Bureau of Mines, Technical Paper 137.

of their temperature and the temperature of the air. An illustration of the effect of mixing on the length of the flame may be had with the ordinary bunsen burner. Cover the air inlets at the bottom of the tube and the flame will be long. Open the air inlets and the length of the flame will decrease, although at the same time the velocity of flow through the burner tube will be increased, as in addition to the gas a portion of the air reaches the flame through this tube.

When the temperature of the flowing gases is known, or can be approximated, a formula can readily be derived by which the vertical velocity may be computed. Convection currents of this kind are rarely appreciated at their true velocity. A temperature difference of one degree centigrade supplies a head sufficient for a velocity of 0.88 ft. per second. As the temperature difference between the air and the gases over the fuel bed will be between 1300 and 1400 deg. C., the vertical velocity of the hot gases will be considerable. This is the reason that it has been found necessary to increase the height from the grate to the lower tubes in many water-tube boiler settings. It is the reason that boilers of the Delray, Badenhausen and Hornsby types give better results than boilers set closer to the grate. It is one of the reasons that has resulted in the adoption of oil fuel for marine boilers. At the same time the writer is convinced that from a combustion viewpoint it would be possible to improve upon the setting of boilers similar to the Delray type by a consideration of the research work of Professors Groume-Grjimailo and Yesmann, of the Polytechnic Institute of Petrograd, which has been successfully applied by them to the design of many metallurgical furnaces.

Causes of Formation of Soot

In boiler practice soot is generally considered to result from the breaking up of the hydrocarbon gases distilled off below the ignition temperature of the fuel. If this is the case, it is also due to the fact that the amorphous carbon has then been chilled to a point below its ignition temperature before it has had an opportunity to combine with oxygen. There is another cause for soot formation that is not so well known; namely, the dissociation of carbon monoxide, forming amorphous carbon and carbon dioxide.

The writer has often speculated as to whether this reaction might not account for a high ratio of carbon dioxide in the off gases[2] when these gases had come at a low temperature from a boiler baffled to attain high gas velocity. This reaction is well known in metallurgical practice, for a number of years ago Sir Lowthian Bell discovered the carbon deposit caused by it in the upper and cooler portion of a blast furnace. Sainte-Claire Deville had previously discovered that carbon monoxide could be decomposed at a low red heat, giving a carbon deposit. It has been found by Boudouard and Haber that this reaction occurs between 1000 and 300 deg. C. and that water vapor contained in the off gases seems to act as a catalyzer. This reaction frequently accounts for a portion of the soot formed in the gas mains of steel plants, and the reverse reaction, the formation of carbon monoxide from carbon and carbon dioxide, occurs in the gas checkers of regenerative furnaces. This reaction may also account for a large portion of the soot formed in the rear gas passes of boilers and in economizers. It would also account for the absence of carbon monoxide from the waste gases in many cases and a resulting increase in carbon dioxide.

In boilers set in the prevailing style the off gases are generally swept over the chilling water-cooled surfaces long before combustion has been completed and every condition is favorable to the decomposition of the carbon monoxide, particularly with high-velocity baffling.

The remedy for this condition lies in designing the boiler setting so that the reactions of combustion can occur before the off gases have an opportunity to reach a water-cooled surface. This is not impossible. A partial attempt is frequently made to do this by the use of a so-called "coking arch" over the fuel bed. Henry Le Chatelier speaks of this arch as follows: "But unless this arch is designed to form a bell or inverted pocket in which the gases may remain a short time, the passage of the unburnt gases is too rapid and the effect of the combustion chamber is imaginary."

Preventing Decomposition of Carbon Monoxide

After combustion has been completed, there will be no soot, as the hydrocarbon gases will be decomposed at such a high temperature that the resulting carbon will become ignited and there will be no carbon monoxide to decompose. A boiler furnace designed to effect this result would place the fuel bed so that no portion of the water-cooled surface was exposed to its radiant heat, and it is frequently urged that some considerable part of the heat received by boilers is due to radiation. In metallurgical furnaces fired with solid fuel it has been demonstrated that a combustion chamber and laboratory (the hearth of a reverberatory furnace) so designed that combustion was completed before the gases had any chance to become chilled gave much better results, in fuel consumption and in product heated, than one that disregarded these principles. With the elimination of soot one of the biggest obstacles to heat transfer from the gases to the metal surface disappears.

In ingot-heating furnaces it has been found that the rate of heat transfer between the hot gases and the ingots depends on the temperature difference. In this case there was no soot deposit to retard the rate of flow. In these and similar furnaces it has been found that a heat drop in the furnace of from 80 to 200 deg. C. per second between the inlet and outlet of the laboratory occurs. The quantity of material heated affects the quantity of gas required. One important feature is the location of the off-gas outlet. It is desirable to have this located so that the gases pass down to it. This location insures the keeping of the laboratory full of hot gas and the cooler gases are immediately drawn out of the heating chamber.

One of the elementary principles of furnace design and one that is frequently neglected is the fact that there is a considerable difference in the specific weight of a unit volume of gases at different temperatures. As a result of this there is what may be called chimney action. The static pressure at the top of a vertical pass may be greater than at the bottom. Where heated gases in cooling pass upward, as in a chimney, they may occupy the full area of the chimney, but the chances are very much against it. The heat of the gas may be and usually

[2] The term "off gases" denotes the gases resulting from either complete or incomplete combustion.

is sufficient to impress a velocity upon the ascending gas sufficient to cut down its stream area, leaving the balance of the chimney area free for a downward current of cold air and an upward one of slightly heated air. This effect may be observed on an experimental scale by noticing the velocity of the stream of smoke ascending from the end of a cigar. This stream of smoke, it may be noticed, has an errand at the ceiling if the surrounding air is quiet; further, it cones in just above the base and wiredraws itself as it ascends. All ascending currents of heated gases act in this manner.

The only chance for a current of hot gas to fill the full area of the flue arises when the gases pass down the flue. A very pretty mathematical proof may be made of the theorem that when two passages are open for the ascent of a current of hot gas the largest portion of the stream will pass up the passage which is the hottest, and conditions may arise resulting in reverse circulation in the cooler passage. This is one of the cases where theory and the behavior of the hot gas agree perfectly.

Settings Usually Designed Improperly

The usual form of boiler setting is designed with an utter disregard of a principle of elementary physics; that is, the hot gases are taken off at the top or as near the top as possible, and are introduced at the lowest point possible. The baffling is arranged to present the largest amount of free area immediately above the grate, at a point where the gases are hottest and have their highest vertical velocity. Then the area of the passes is decreased, presumably because the gases get cooler. The writer will agree that the usual third pass may be small, but he cannot see any reason for a baffle separating the first and second passes. The cooler gases will fall below the hotter and lighter gases due to the difference in weight. However, it might under this condition be desirable to extend the baffle between the former second pass and the third pass down very close to the bottom of the setting. It might seem that this would result in a short-circuit from the firebox to the third pass. Experience with the down-draft brick kiln does not present any trouble of this character. In fact, the temperatures attained in the down-draft kiln cannot be reached in the up-draft kiln.

Boilers without any baffles have been successfully used in connection with waste-heat utilization on copper-smelting furnaces, and the same type of boiler with baffles has been used in connection with cement kilns. A better design of waste-heat boiler has been installed in connection with openhearth furnaces.

Probably the main difficulty in connection with steam generators arises from the fact that the ruling temperature is very low—so low that it would be extremely difficult or nearly impossible to design something that would not work. Many thousands of boiler installations bear witness to this. The last word in boiler designing and the arrangement of settings has not been said.

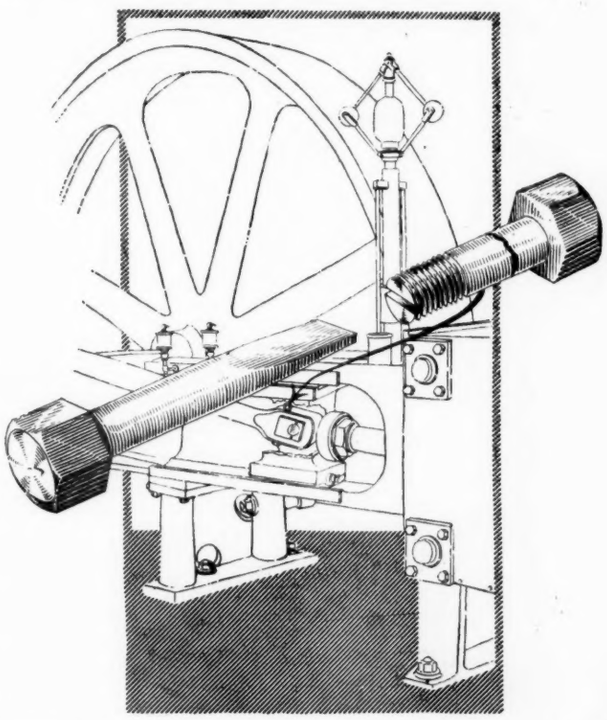
One practical feature of boiler operating that has not been touched is the dust question. The carrying power of a stream of any character varies as the sixth power of its velocity, and there are cases in which the dust evil is serious. A high velocity will tend to carry dust through the boiler, and unless the passes are properly designed, eddies will be formed which will fill up with dust in a most surprising manner. *Power* a year ago showed an interesting case of a soot deposit which settled on a horizontal baffle[3]. The cause of this was that the gases in their flow behaved as a stream, an inverted stream of water, instead of sweeping through the entire area of the pass, as the designer expected. A knowledge of the gas temperature and volume in this boiler would have enabled the designer to apply Yesmann's formula and to proportion the pass so that this eddy would not have been as large as it was.

The investigations of Mallard and Le Chatelier and of Damour enable the computing of curves from which the heat of combustion under various conditions of air supply may be very closely approximated. In these computations the assumption is made that combustion occurs in an athermal enclosure, so that the temperatures reached in actual practice are lower.

Removing Broken Adjusting Bolts

A handy tool can be made from a capscrew for the purpose of removing broken adjusting bolts from a wristpin adjusting wedge where a screwdriver cannot be used on account of the crosshead guide.

A screwdriver end is formed on one end of a capscrew and the head is left for turning with a wrench. This makes a tool just long enough so that with the engine on the quarter-stroke, there is room to insert



TOOL FOR REMOVING BROKEN ADJUSTING WEDGE BOLTS

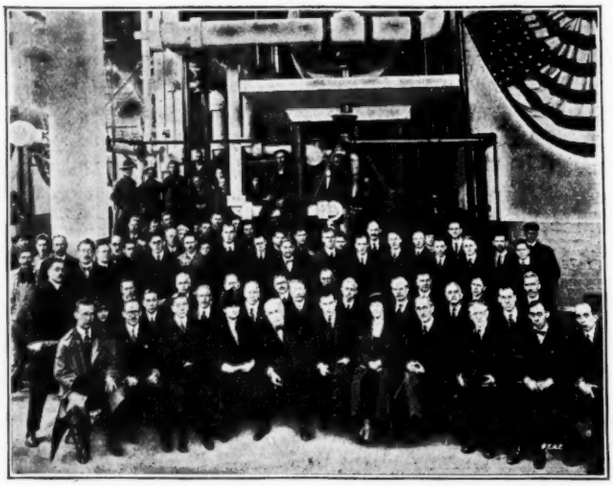
the tool. The adjusting-wedge bolt ends are, of course, slotted with a hacksaw before being put in place.

Before this tool was made it required an hour to put in a new bolt, because it was necessary to remove the wristpin from the crosshead in order to get the broken piece of bolt out of the adjusting wedge. Using this tool, it is possible for one man to do the job in from five to ten minutes.

[3]Dec. 25, 1917, page 875.

Edison "Lights Up" New Boiler Plant

ANYONE having a mental picture of Thomas A. Edison as a laboratory dreamer, interested only in the abstruse, would revise it materially on seeing him "in action" and hearing those of his "family" at the West Orange plant tell of the intimate contact he maintains with everything doing there. It was he that started the fire under the two new 600-hp. water boilers put into service Jan. 2, 1919. This was not Mr. Edison's first introduction to the plant, for he has taken an active interest in it from first to last—no less than 14 different layouts were prepared, before his final O. K. was obtained. The boiler house, as nearly centrally located as possible in relation to the buildings served, is 90 ft. long by 60 ft. wide, with provisions for extension to a width of 100 ft. when other boiler units are installed. It was Mr. Edison's desire that reinforced concrete be used wherever possible, even to the 150-ton overhead coal bunkers and roof span of 40 ft., which proved to be difficult pieces of construction. About 11,000 bags of cement were used in the building construction. The cost of the present structure with its equipment exceeded $300,000. Considerable difficulty was encountered securing firm footing for building and stack on account of the nature of the subsoil. The stack, 10 ft. inside diameter, 202 ft. high and weighing about 1000 tons, rests on a base 30 ft. on a side, which in turn rests on about 150 wooden piles. The building basement is below the sewer grade and below the mean ground-water level, so that this floor and the lower part of the wall must not only be waterproof, but must resist a hydrostatic head of three or four feet. The two boilers just put into service constitute one-fourth of the final capacity (5000 hp.) contemplated. One of the outstanding features of the plant layout is its compactness. On the raised platform to be seen at the rear of the group in the upper picture the boiler-feed, water heater is located, giving a satisfactory head to supply the centrifugal boiler-feed pumps. The economizer is in the basement, with the scraper-operating mechanism level with the main or operating floor so that the mechanism is unusually accessible and the cleaning operation is performed in the basement, from which all the ash is removed in small cans to a skip hoist delivering to an overhead bunker. It has been the aim to design this plant to operate as economically as possible under practically constant 24-hour load. Provision has been made to return the condensate from all process apparatus through the plant to a large tank in the basement of the boiler house to be delivered to the feed-water heater and boilers. Following the lighting of the fires under the new boilers an informal luncheon was served in the boiler house in the spare space designed to receive the next two boilers, to upward of 100 guests. Charles Edison made a few informal remarks, and music was furnished by the Edison Employees' Band, led by Professor Restorfs. Mrs. Thomas Edison and Mrs. Charles Edison attended and took a lively inter-



GROUP AT LUNCHEON IN THE BOILER HOUSE

THOMAS A. EDISON APPLIES THE TORCH

est in the exercises. The design and construction of the plant was in charge of John P. Constable, chief engineer; C. A. Nicolia, division manager of the construction and maintenance division; M. A. Wolf, construction engineer, and F. J. Riker, power service division manager. Among the officials of the Edison industries, in attendance in addition to the committee in charge, were: S. B. Mambert, vice-president and financial executive; C. H. Wilson, vice-president and general manager, whose retirement owing to ill health has been announced; Harry Miller, treasurer; William H. Meadowcroft, assistant to Thomas A. Edison; George E. Clark, special assistant to Charles Edison; James F. Monahan, superintendent of the Edison Storage Battery Co.; Charles W. Luhr, superintendent of the Edison Phonograph Works; William Dykeman, purchasing agent.

Reversed Heads in Pressure Vessels

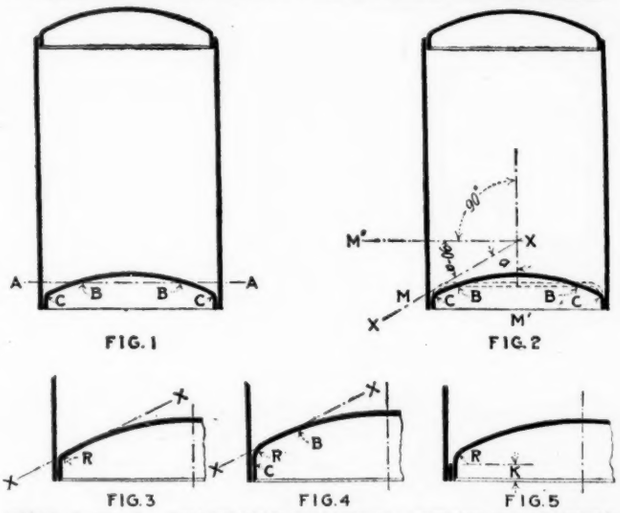
BY JAMES LESLIE LANE

Notwithstanding its many advantages, from the manufacturer's point of view, many engineers believe that the reversed bumped head in receiver and pressure-tank work should be done away with. The author considers it to be one of the most abominable makeshifts allowed by the code today, and that its disadvantages so far outweigh its good points as to make its use positively bad practice.

IN THE pioneer days of the boiler industry, when but few mathematical data on such work were available and when inspection was almost unknown outside of perhaps one or two of the larger cities, it was but natural that the reversed head should have been used. Pressures were low and strength was less important than tightness. The advantage of backing a head in was obvious. It made riveting and calking much simpler, did away with a manhole that would otherwise have been necessary, and in cases where the drum was to be stood on end avoided the use of a cast-iron base or supporting framework. There was little machinery for manhole cutting or flanging, and as this had to be done entirely by hand, the cost was considerable.

Later, when pressures increased and laws were enacted covering the construction and installation of boilers, some of the objectionable features of this practice became apparent. When the tank was set vertically, it was found impossible to drain it completely; for if the outlet was placed in the center of the head there was always water remaining below that level. Locating the outlet close enough to the bottom of the shell to remedy this fault was not only difficult, but left an opening that soon became clogged. The second drawback was that this dead space served as a settling chamber and mud catcher, where oil and sediment could collect. This feature was bad as there was always a chance that the oil would eventually find its way into the boilers and cause serious trouble. This was overcome in time by demanding that tanks so constructed should be set horizontally. But there were other difficulties to contend with, especially in regard to strength.

The matter of calculating the ultimate bursting pressure of a head inserted in the regular manner, and hence its safe pressure, is not a difficult problem, although it is somewhat complicated by the fact that a bending moment is introduced at the point where the flange and the head proper join. This causes the head to breathe slightly under excessive pressure, but the error it introduces into such calculations is not serious. The case of a bumped head resisting collapsing pressure is far more difficult, however, as it is somewhat analogous to buckling in bars. If the cross-sectional area of a bar is known, as well as the tensile strength, its ultimate rupturing strength can be accurately determined. What the same bar will do under a compressive stress depends on its shape, length, manner of applying the stress, etc. The formulas for determining its resistance to buckling are mostly empirical; that is, deduced from actual experience and tests. The same is true of bumped heads, the number of factors introduced and the uncertainty of their action making a clear-cut and exact mathematical formula out of the question.



FIGS. 1 TO 5. DIAGRAMS SHOWING ACTION OF FORCES IN DISHED HEADS

Not a little hinges also on the individual workmanship and the accuracy with which the head is shaped to a given radius. Before collapse can begin, some small part of the head must be flattened by the pressure. This is difficult if the curvature is exactly the same at all points on the sphere and the stresses set up in it are balanced; but if in the beginning some small portion is left flat and a leverage afforded the tendency to collapse is cumulative. In fact, it might be said with fair accuracy that in every case where such failure occurs under pressure the beginning was made at a flat spot.

Where the pressure is on the concave side, such a fault tends to correct itself by forming the head to a circle; in a reversed head it tends to accentuate itself and lead to a failure of the whole. Accurate workmanship cannot, therefore, be too strongly insisted upon.

Installing a badly shaped head is analogous to putting into a building columns that are already buckled and out of true. Both invite failure and should not be tolerated.

These faults, the impossibility of deducing an accurate formula for collapsing pressure and the practical certainty of imperfect curvature, have been allowed for by stipulating that such heads shall have a minimum thickness considerably greater than would be the case if they were put in in the regular manner and the pressure applied on the concave side. These restrictions take care of the stresses set up in the head itself, but do not allow for the effect of breathing or swaying on the shell.

Turning to Fig. 1, observe what form the bumped head will first assume when a distorting pressure is applied and what stresses it will develop in the shell. The problem is similar to buckling in a beam, and whatever distortion appears will be about the neutral axis *AA*, no effect being noticeable at the points *B* where the axis cuts the head.

If the part *BB* is to bulge outward finally, it must first be flattened, the part *BC* of the head being distorted and assuming the shape shown in Fig. 2. This places the part *BC* in compression and the stress will be exerted along the tangential line *XX*. Without attempting to determine the exact intensity of this stress, assume it to be *M* pounds and resolve it into its two components, one parallel to the axis of the shell, the other at right angles to it.

Supposing that the line *XX* makes an angle a with the axis of the shell, then the force *M'* acting parallel to the axis of the drum will be $M \cos a$ and its effect will be wholly exerted on the rivets holding the head in position. The force *M"* acting at right angles to the axis of the drum will be $M \cos (90 \text{ deg.} - a)$ and its effect will be partly exerted on stretching the metal in the part *BC* of the head, and in expanding the shell of the drum itself. To put the problem in a simpler way, the action is a toggle effect, the outer rim of the head being stretched and forced out against the shell, tending to rupture it.

Just how much of this toggle effect is brought to bear on the shell of the drum depends on the radius *R*, where the head meets the flange. If the radius is small, as in Fig. 3, then any expansion of the head must affect the shell, for the thrust comes directly against it. On the other hand, if this radius is large, as in Fig. 4, the part *BC* of the head is free to spring and the stretching of the shell is minimized. This would lead to the conclusion that in reversed heads the radius at the knuckle of the flange should be considerably larger than in the case of straight dished heads of the customary type. In order to reduce still further this toggle effect, the writer believes it would be advisable to insert a filler piece between the flange of the head and the drum, as shown in Fig. 5. It need not be thick—probably one-eighth inch would be sufficient—and where possible it should be of copper. Its width *K* should not exceed 2½ in., in order that a clear space be left above to take care of any expansion of the head.

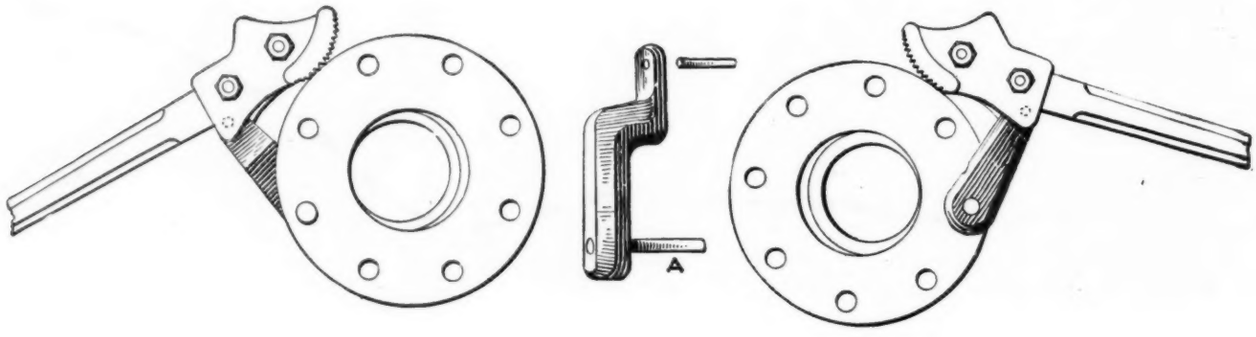
Summing up, then, the advantages of a reversed head are: (1) The possible elimination of a manhole where the drums are small; (2) the elimination of a cast-iron base or supporting lugs where the drum is to be set in a vertical position; (3) the possibility of doing the riveting on a bull.

Opposed to these are the following disadvantages: (1) The impossibility of proper draining, with the attendant danger that oil may find its way into the boilers; (2) the settling chamber formed, and the danger of clogging the outlet pipes; (3) the additional thickness of plate required; (4) the wholly empirical formulas on which such plate thickness must be based; (5) the ever-present element of danger due to faulty curvature; (6) the additional load that such construction puts on the shell joints.

This latter list is a formidable one, and where safety is a necessary factor to be reckoned with it far outweighs any initial saving in construction. The defects are too glaring, and in offering the foregoing suggestions the writer does not mean that such changes would entirely eliminate them, but would rather minimize their effect in cases where such doubtful practice is adopted.

Ideal Flange Attachment

Engineers are familiar with the chain type of wrench, in which the gripping jaws are toothed to prevent slipping on the pipe, and a chain causes the gripping head to grip the pipe as pressure is applied to the handle. An attachment has been made to be used in connection with the chain wrench, shown herewith, known as the Ideal flange attachment and made by Kroeschell Bros. Co., 440 West Erie St., Chicago, Ill. As shown in the illustration below, the attachment consists of but one member, a steel link *A*. One end swings on a pin held between the jaws of the wrench members, and the other end carries a pin that engages in the bolt holes of the flange. When used, a grip is obtained on the rim of the flange. This wrench with flange attachment is made in six sizes with a total range of from ½ in. to 20 in. in pipe sizes.



EDITORIALS

Wages and the Engineer

IN THE reconstruction problems now confronting the industrial world, the question of wages and wage-scale adjustment takes a prominent and highly important part. Reconstruction in its broadest sense brings added responsibilities, creates greater need for conscientious and rightly directed thought, and demands a careful exercise of judgment for resultant action. And so, indeed, with the wage question, for probably no other phase of industrial operation is of such primary consequence from the viewpoint of both employer and employee.

Of the former there are two general classes. On the one hand is the man or concern that seeks to "cut" right and left to save so-called overhead, regardless of conditions or circumstances, and with equal disregard for ultimate consequences. But little thought, frequently, is given before acting, the one and sole aim being to "save the dollar"—and the dollar is held so close to the eye there is no seeing beyond. On the other hand stands the right-calibered executive, the man who thinks before he acts, and in that thinking carefully takes into consideration all factors that go to make up the full situation, such as plant atmosphere, employees' welfare and living, as well as general betterment, and the big values to be derived for the business by helping his men to maintain a present or right status of home and existence.

Among the wage earners, and primary wage earners, are the stationary engineer and fireman. The results of their efforts are of vital importance—they start the wheels of the plant or factory moving, for without steam or electric power for operation there can be neither industrial activity nor works production. To a far less degree than skilled workers in other lines of endeavor have these mainstays of factory operation been benefited by advancing wages. There have been general increases in wage rates here and there, for such had to be with the advancing costs of living, but the increase has been small compared with the added compensation in other lines. Shall this advance, such as it has been, now be taken away and former schedules resumed? It would seem not only unfair to the men directly concerned, but decidedly wrong and injurious, and in more ways than one.

Thus when we find a body of employers getting together in common council and urging a maintenance of wages for the engineer and the fireman, as well as for skilled workers and even common labor in other branches of industry, we are impressed with the fact that a sort of new spirit is alive, that the day of real coöperation is here. Unquestionably, it is a big move in the right direction; it is the impelling force of right coördination, which cannot help but be substantially beneficial.

At a recent meeting of the Manufacturers' Council of the State of New Jersey, held at Newark, the wage question occupied a first place in the discussions of the day. This gathering, known as a readjustment convention, was the first of its kind in any state of the Union. Here it was pointed out that the desire on the part of all, both employers and employees, was for a return to the normal working day, with elimination of overtime, and further, that employees in the average run sought only a right wage schedule commensurate with the present cost of living. In line with these views a resolution was adopted unanimously, reading:

> It is the sense of this convention that wages should be the last thing to be reduced, and that, in justice to the worker, in so far as possible, present wage schedules be maintained until the purchasing power of the dollar increases.

Another interesting result of the meeting was the formation of an Industrial Commission for the Council, to bring about friendly coöperation on the part of manufacturers in different lines, formulate definite plans for matters of immediate readjustment, and effect a better understanding, where needed, between employee and employer. This commission will be composed of five members each from four primary branches of industry—manufacturing, public utilities, agriculture and banking—and a total of ten members to represent labor. Five of these latter will represent the power end of business, termed public utilities in the broad phase, giving a hearing to the engineer, firemen and other power-station employees, as might be desired.

The plan as arranged carries every earmark of successful attainment. There is no better way to iron out difficulties, regardless of their nature, than to get together in common council on equal ground and "talk it over." Fully one-half, if not more, of the trouble disappears when the two sides meet, and the rest can be taken care of readily and in the right manner by a fair and impartial discussion and an equitable adjustment satisfactory to both parties.

Employers in other states might well watch the results of the New Jersey Industrial Commission. That they will be followed with interest there can be no question, and every indication goes to show that the engineer and power station employees, as well as general industrial workers, will be given not only a "square deal," but in the spirit of reciprocity, considerate and fair-minded treatment; and in the initial as well as final reckoning, they themselves will have an important voice.

Cost of Banking Fires

ONE of the items that enters into power-plant costs, and that cannot be directly figured in the production of power, is the coal used in banking fires, during the night in some instances and during the day in others, where some of the boilers are used to carry the morning and evening peak loads.

Naturally, the attendant will burn his fires down before the banking period. With hand firing the live coals are pushed back against the bridge-wall and

covered with sufficient green coal to carry the fire over the banking period. With stokers various methods of banking are employed, depending on the type of stoker. Regardless of the type of furnace, the coal used for banking fires cannot be figured in with that burned to evaporate water. As a matter of fact, very few boiler plants keep a record of the amount of coal used for banking and still less is known as to how much of the banking coal is consumed during the banking period.

Naturally, the size of the boiler and the period of banking will determine largely the amount of coal used in banking fires, but other factors also enter, such as the condition of the damper and kind of coal used.

It has been estimated by some that the coal required for banking is about one-third of that required for the day's run. This seems somewhat high, but in the absence of published data covering the subject, there are but few figures to confirm or disprove this estimate.

It would be interesting to know what engineers in various types of plants have found regarding the amount of coal used in banking fires; also, the amount that is consumed during the banking period. It is probable that many engineers have these data, but have not deemed them of sufficient importance to give to the technical press for publication. The fuel situation at the present time makes it imperative that every engineer shall know just what amount of coal is consumed for the various operations in his plant, and that of banking is no exception. If there are engineers who have kept a record of the coal used in banking fires, others who are interested in this subject would welcome these data, and we shall be glad to publish them.

The Engineer and Conservation

FOR the operating engineer and all power-plant operatives, the events of the last four years brought forward only a few new problems, the chief one being that of obtaining supplies, particularly an adequate supply of fuel. Economy in the operation of the plant in every particular is not a new problem or a new practice to the first-class man in any plant, large or small, in which he may be found.

It would seem from the popular press that a study of economy was something new and entirely foreign to the power plant and the engineer. The fact of the matter is that there are few if any trades or professions in which men continually devote more time and money to maintain organizations for the study of their work, for the benefit of their employers and in the hope of advancing themselves thereby, than that of the stationary engineer. In many places the men meet and devote an entire evening a week to educational work, paying their dues cheerfully to defray the expenses for hall rent, heat, light, etc., without a "come back" from anywhere. It is a safe challenge to those in any other line to show a greater effort toward personal proficiency than has been the practice of the stationary engineers for the last twenty-five or thirty years.

The struggle for economy and efficiency in the power plant is new to the general public and in many cases to the management, which is now coöperating to some extent, but it is by no means a new thing to the engineer. Now is the time for the engineer to show what he can do when given the proper support.

No Government Bargains in Power Plant Apparatus and Supplies

THE sudden close of the war has found the Government with a large amount of machinery and supplies upon its hands for which it has no further use. Opportunities for bargains are being sought, both by those who have legitimate use for such machinery and supplies and by those who would like to purchase them at a sacrifice price and resell them at the market value.

L. H. Hartman, Chief of the Surplus Property Division, in a recent address to the Chicago Association of Commerce, explained that as many of these goods as possible would be disposed of to foreign countries and to different departments of the Government. Contractors and purveyors of supplies will be given every opportunity to repurchase, so that the unloading of these goods upon the market may not interfere with their regular trade. Only after such sources of distribution have been exhausted will individual purchasers be considered.

By a study of the load curves, desirable results have been accomplished in Massachusetts. It has been found possible to shut down generating units hitherto in continuous operation to take care of peaks. Now that the war is over there should be no let-up in studying peak loads and other power-plant conditions. Conservation of fuel is still the order of the day, not particularly because of a coal shortage, but because wasting coal is wasting money.

Caring for hot-water heating systems is viewed from different standpoints. Opinions are divided as to the advisability of emptying the system of water at least once a year. Some are in favor of so doing, others are opposed. What is the opinion of users of hot-water heating systems?

The model soldier does what he is told to do, in the way he is expected to do it. If there were more of that spirit in industrial life we should not hear so often the familiar complaint, "If you want a thing done the way you want it done, do it yourself!"

Until quite recently the only standard that the United States Army had for buying coal was that it should be equal to a ton of good hard wood. Some of the alleged coal that was sold last winter would make a pretty big dent in even that standard.

How things change! It was only a few years ago that an editorial in a then well-known technical journal discussed the question as to whether the steam turbine was suitable for driving dynamos. Wonder what the author thinks today?

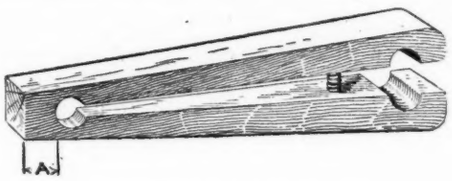
By what principle of economics is it figured out that the best way to keep a people from suffering for the necessities of life is to keep them at work making something for which they will have no need?

As a general proposition, the higher the furnace temperature the greater the efficiency. If you believe this to be so, stop up those cracks in the boiler setting.

CORRESPONDENCE

Tool for Removing Fuses

It is sometimes difficult to remove small inclosed fuses from their clips, especially if they happen to be in an inconvenient place. The illustration shows a very serviceable pair of fuse pliers I made of a piece of fiber. Two holes about ¼ in. in diameter are drilled in a solid piece of fiber, and then the block is sawed



HOME-MADE FUSE PLIERS

open as in the sketch herewith, thus opening the pliers. Inserting a small steel spring as shown will keep them open normally and make them convenient to use with one hand. The distance *A* can be made suitable to the user's fancy; in mine it is about $\frac{3}{16}$ in.

Norristown, Penn. WILLIAM H. WATSON.

Practical Coal-Saving "Stunt"

Since we have been told that engineers must save at least 35,000,000 tons of coal this winter, the following true story of how one superintendent cut down the consumption of fuel at a small power plant is of interest: After he had heard the cry, "Save coal and more coal," he thought he would try and see if he could do anything that might cut down the fuel consumption. Being an old hand at firing, he stayed around the fireroom to see if the boys understood their business well. He discovered that they were pulling the fires before they had gotten the full value of the fuel and that they were not firing in a proper way, heaping the coal right in the center of the fires. He showed them that it would be easy work for them to keep up the steam and save coal if they would keep their fires level and not be continually damping them by putting fresh coal on. To their surprise the superintendent reported at the end of a week that they had saved 4½ tons of coal. In one year that would amount to 225 tons saved on four fires.

These facts prove the truth of the saying that it is the man with the shovel who controls the use of coal.

Plymouth, Penn. JOSEPH R. THOMAS.

What Is an Engineer?

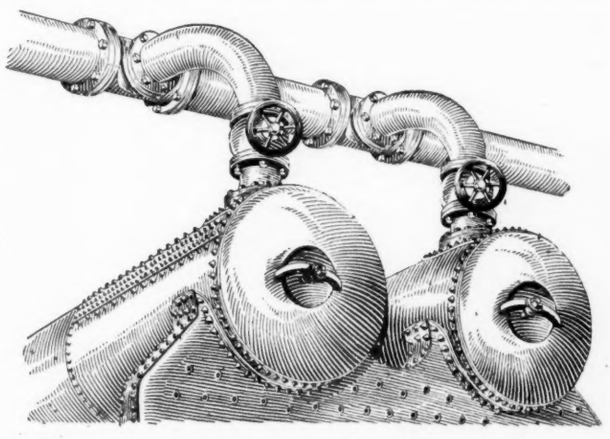
A. H. Krom, Director of Engineering, United States Employment Service, has proposed the following definition of an engineer: "An engineer is one who economically directs man power and by scientific design utilizes the forces and materials of nature for the benefit of mankind." This definition it would seem admits many men to the engineering profession who are not engineers. There are many men economically directing man power who have nothing to do with engineering. It seems to me that the definition should be changed, and the following is suggested: "An engineer is one who economically directs man power in the utilization of the forces of nature and the use of the materials of nature for the benefit of mankind."

In regard to the definition for a mechanical engineer, the following has been suggested by Prof. J. J. Flather, of this University: "A mechanical engineer is one who scientifically designs, or economically directs the construction and operation of, machinery and mechanical apparatus for the benefit of mankind."

JOHN R. ALLEN,
Dean, College of Engineering and Architecture,
The University of Minnesota.
Minneapolis, Minn.

Difference in Water Level

The letter by C. S. Regan in the issue of Nov. 26, 1918, page 786, calls to mind an experience I once had with a battery of two-drum horizontal water-tube boilers. As shown by the illustration, each drum was connected to the header by an independent steam line. When cutting one of these boilers into service, if the stop valve on the drum to which the water column was connected was opened first, the water would rise to the



TWO-DRUM BOILER WITH TWO STEAM CONNECTIONS

top of the column and the header would be flooded, while if the valve on the other drum was opened first, that header would be flooded, but the water would disappear from the column. This, of course, was the result of the unbalanced pressure in the drums, due to opening the valves one at a time.

To avoid the trouble, it was only necessary to open both valves simultaneously, thereby maintaining a practically balanced pressure in the drums. If Mr. Regan's boilers were connected up in the same manner, it is

possible that the flow of steam from one drum is more restricted than from the other, owing to friction in the steam lines which results in an unbalanced pressure of perhaps only a fraction of a pound. A column of water one inch high exerts a pressure of less than six-tenths of an ounce per square inch, so it can readily be seen that a difference in pressure of a very few ounces could easily account for a difference of two or three inches in the height of the water. If the drums were connected by a cross steam drum with a single outlet, my theory (if such it may be called) would hardly apply, unless the steam legs of the cross-drum were served by dry pipes having unequal area or the flow of the steam through one of the legs was otherwise restricted. As no difference in water level developed until the boilers were cut in on the header, this would further support my claim that an unbalanced pressure existed in the drums, due to an unequal flow of steam therefrom. T. D. BROWN.

Akron, Ohio.

If the water level is the same in both columns when the boilers are not working, the trouble must be in the steam outlets to the main. The one in the drum that the water rises higher in must be the larger. Uneven heat and uneven draft or fire under one drum would cause the water to circulate more rapidly, and the water would rise higher in that drum. If both steam and water connections of the columns are direct from the drum and are the same size and are clear of scale or have the same number of elbows and tees up to the column, then the trouble may be in the gage-glass valves.

I once had such an experience and found my trouble in the gage-glass steam connection. The steam valve had become almost closed up by scale and pieces of packing. Some water glasses have small needle valves and the steam end may be almost closed off and the water end wide open, and with the boiler working, the water will rise two to four inches higher in the glass than the true water level in the boiler. A good way to test two columns would be to connect both to the same drum on the same pipe; then if they show the same water level, it must be overheat or overcirculation in the drum that influences the water level. I have never seen two boilers that worked just alike or any two-drum water-tube boiler that had an even circulation in both drums. P. B. WILLIAMSON.

North Kansas City, Mo.

I have had considerable experience in the operation of large cross-drum boilers, and a similar problem was once encountered. The boilers in question were 44 tubes wide and were equipped with a double-loop superheater. The steam outlets were at either end of the superheater header, which ran the full width of the setting. The boiler was fired with two underfeed stokers, one being located at the front and the other at the back. The boiler was fitted with two water columns, one at either end of the drum, and indicating thermometers were supplied on each steam outlet. For some time it was noticed that a considerable difference, fully three or four inches, existed in the level of the water in the two columns. This difference was especially marked when the boilers were being forced. It was finally discovered that the temperature of the steam leaving one side of the boiler was considerably higher than that leaving the other side and that the hottest steam was indicated on the side of the boiler showing the highest water.

To account for this a thorough study of the conditions in the boiler was made. It was found that one side of the fire in the furnace was in considerably hotter condition because the coal was fed to the stokers by a coal chute that was placed at such an angle that the coarse coal all went to one side and the fine went to the other. This, of course, caused very uneven fires with the result that one side of the boiler was evaporating more water per square foot of surface than the other. The gases were so much hotter on that side that the steam in the superheater was much higher in temperature. This condition existed until the coal chutes were replaced by traveling weighing lorries which gave an even distribution of coal over the entire stoker. After this it was, of course, possible to carry fires that were more nearly the same all the way across the furnace. From that time on the discrepancy was less apparent and it was possible, at times, to have the steam temperatures read within a few degrees of each other. The water levels also were more nearly the same.

While it would be necessary to know more of the conditions that existed at the time the trouble occurred as described in the article of Nov. 26, it would seem that part of the trouble, at least, may have been due to uneven fires. This would cause the water to boil much more violently on one side of the boiler than on the other and cause a higher water level in that drum.

Hazleton, Penn. F. C. TORRANCE.

Trouble with Belt Tighteners

The illustration submitted by Mr. Eckert (Dec. 10, page 856) shows a tightener that is moved into and out of contact with the belt by means of a handwheel, screw and gears and that the tightener is nearer the driven pulley, which in this case is the smaller of the two. A so-called "tightener" in addition to increasing the tension should increase the arc of contact of the belt on the smaller pulley and should therefore be placed near the smaller pulley. In the installation described, however, the idler should be placed near the driving pulley for the reason that this is where it will best take care of the stretch in the belt that occurs with a sudden increase of the load. The tightener should be of the swinging or of the weighted type because the hand-operated kind will not adjust itself to the stretch of the belt. Whether the idler pulley is straight or crown-faced does not matter so much provided it is square with the belt. Mr. Eckert's difficulty is no doubt due to the use of the fixed type of tightener, wrongly placed and probably a little out of line, any one of which elements will cause trouble.

There seems to be some prejudice against the use of idlers on belt drives. This is pretty much due to the erroneous impression that they absorb a lot of power. The writer in discussing a certain belt drive with an engineer, suggested the use of an idler. The engineer said he was opposed to the use of idlers on account of the large amount of power consumed by them and that the idler suggested would require at least five horsepower. He was surprised when a calculation involving

the heat equivalent of five horsepower and the probable heat radiation disclosed that any such absorption of power would soon melt the bearing liners. As a matter of fact the power consumed by this idler was but a fraction of a horsepower. C. O. SANDSTROM.

Kansas City, Mo.

Such problems in belt transmission are not unusual. It is probably the result of installing a belt that is too small to carry the load with ease. If the belt and pulleys have been kept clean and the belt pliable, the need of a mechanical tightener would indicate that the belt was too light.

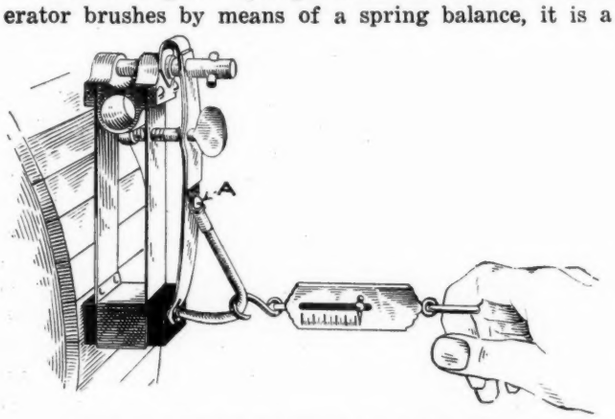
Since tighteners are always a source of danger and annoyance, I would suggest the installation of a "rider belt" of two-thirds to three-quarters the width of the main belt. This rider should always fit snugly with little sag on the negative side. It is in a measure a remedy for the trouble; for by its action it holds the main belt more firmly against the pulleys, reducing the tendency to slip, and greatly reduces the "jump" in the main belt when it does slip to relieve the sudden excess load, and very materially increases the efficiency of the drive.

It is well to remember constant care is the price that must be paid for good results in belt transmission and that neglect and abuse result in loss. J. F. ENGLER.

Tyrone, Penn.

Testing Brush-Holder Spring Tension

When testing the spring tension on motor and generator brushes by means of a spring balance, it is a



TESTING SPRING TENSION OF BRUSH-HOLDER

common fault to hook the balance to the pigtail of the brush as in the sketch. This is incorrect since there will also be a pull at *A*. The proper method is to disconnect it from the clamp holding the pigtail and then pull on it radially. WILLIAM H. WATSON.

Norristown, Penn.

Repairing a Cracked Water Jacket

The water jacket of a gasoline engine was cracked in two places. One of the cracks was a very fine one, while the other one was more open. The larger crack was brazed in the following manner: First, to prevent the cracks from lengthening, holes about $\frac{1}{8}$ in. in diameter were drilled and tapped at each end of the cracks and fitted with iron machine screws coated with shellac to make a tight fit. The wide crack was then prepared for brazing. With a sharp-pointed file the sides of the crack were carefully cut away to form a V-shaped groove, as shown in Fig. 2. Along the bottom of the V, or crack, a very soft brass wire was placed and powdered borax sprinkled over it. The surface around the crack was first heated carefully with a blowtorch and the torch finally brought to bear upon the brass wire over the crack. With sufficient heat the wire was melted and fused into the crack.

The fine crack was not brazed but copper-plated. The water jacket was filled with a saturated solution of

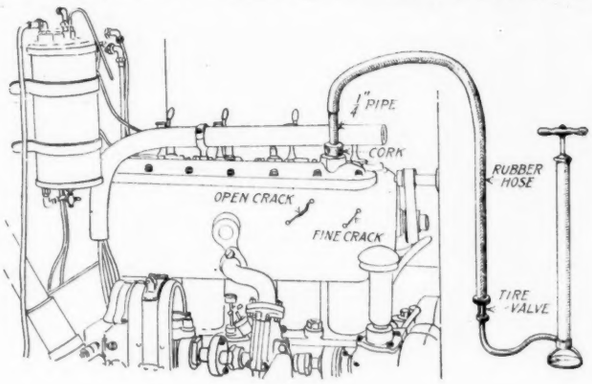


FIG 1

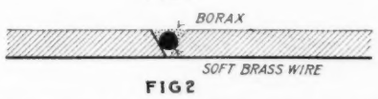


FIG 2

METHOD OF APPLYING THE COPPER SULPHATE

copper sulphate (blue vitriol) made by dissolving the crystals in warm water. At first the liquid leaked through the fine crack quite freely, but it was collected in a pan and poured back into the jacket again. After a time a coating of pure copper was formed in the crack, filling it up and making it tight. The job was considered done, but after the engine had been given a short run, a little leakage was still noticeable. To eliminate this fault, the copper-plating process was applied again by holding the copper-sulphate solution under air pressure by the use of a tire-inflating pump, as shown in Fig. 1. A few strokes with a tire pump was sufficient to create a pressure in the jacket, and when the copper plating was finished there was no leak even under pressure nor was there any leak when the engine was put into service. B. Z. REITER.

Hoboken, N. J.

A Couple of Drinks

There is no excuse for the man who comes on watch with a "couple of drinks under his belt." He is a dangerous proposition and a useless drag on the morale of the rest of the crew. His efficiency is negative as compared with the man who does not require the proverbial "morning eye-opener." His mental faculties are used mostly in marking time, counting the minutes until he can get an opportunity to replenish his false stimulation. And the average drinking man is very much conceited about his so-called self-control. He says he can "take it or leave it," but he never feels inclined to leave a glass just to illustrate his will power.

In one plant there were two Corliss engines driving

generators. One night, with the smaller unit on the line, the night engineer and his oiler took charge as usual. About 6:30 the crank-end dashpot refused to operate. Instead of starting the other engine or trying to ascertain the cause of the trouble, the engineer took a crowbar about five feet long and attempted to pry upen the dashpot. It came up all right, but when the travel of the valve gear reversed, the pick-up hook pushed the block down again with the result that the bar struck the man, breaking his jawbone, and in some unknown manner, when he fell to the floor, his ankle was broken.

All that was wrong with the engine was that the locknut had jarred loose on the dashpot rod and the rod had shortened until the hook could not engage the block in its limited travel. The rod could have been easily adjusted temporarily by hand and the top locknut tightened with an open-end wrench—which, by the way, hung on a tool board about ten feet from the engine.

The man's case was taken into court and on the witness stand he admitted that "he might have had a 'couple of drinks' before he went on watch," but it was proved that he was in four different saloons on his way to work that night. His partner, who he relieved, on being questioned, said that he had not noticed anything wrong with the night man. Maybe not, but he was partly to blame, inasmuch as he left the plant without knowing that everything was right. Fortunately, such incidents are rare, but it seems that a man should have enough sense of honor, if he has to drink, to stay away from the plant while he celebrates. His conduct reflects on all his associates, indirectly.

The gradually increasing load of responsibility resting on the man who operates power-plant equipment is of such a nature that it surely does not permit the couple of drinks. In the case mentioned, a "couple of drinks" cost a certain company approximately a thousand dollars a drink. The lesson is evident.

Chicago, Ill. JAMES J. JAHOBART.

Firing Low-Pressure Boilers

In regard to the cause of the water returning when the steam pressure was lowered in the boilers, as described by J. M. Coleman in the issue of Dec. 10, 1918, page 837, I would refer him to my letter on page 855 in the same issue.

When a lower pressure was carried in the boilers, a lower column of water would be supported and less water would be stored in the system. To my mind this is the cause of what took place and not the more or less rapid circulation of the water in the boilers.

Buffalo, N. Y. THOMAS SUTCLIFFE.

Overcoming Flash-Over Troubles on Direct-Current Generator

In the plant where I am in charge there are two motor-generator sets for electric-railway service. Each set consists of an 11,000-volt synchronous motor, driving a 600-volt 481-amp. direct-current generator, and has been in use for about nine years.

For a long time after these machines were installed, they gave considerable trouble by flashing across from the commutator to the brush-holder yokes and frame about every time a heavy short-circuit occurred on the system. Since this trouble occurred on the generators, the circuit-breaker could not protect the machines, consequently the overload always stalled the motor and often roughed the commutator of the generator, causing considerable interruption in the service.

The trouble was overcome about two years ago by raising the brush-holders about $\frac{3}{8}$ in. from the commutator. We also painted the brush-holders with an insulating paint and wrapped the yoke with linen tape. But I think raising the brush-holders was what overcame the trouble. At any rate, no flash-overs have occured on the machines during the last two years.

Deadwood, S. D. W. W. CASSIDY.

Unusual Cause for Circuit-Breaker Heating

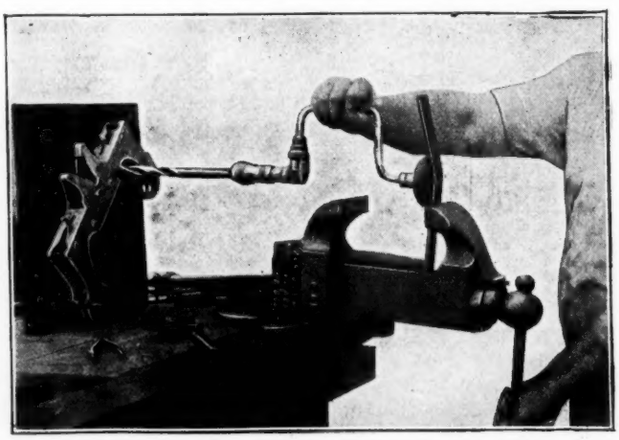
We had trouble some time ago with a circuit-breaker heating. The contact surfaces were thoroughly cleaned without avail, and the breaker was taken down and given a further careful cleaning, but still it heated up.

The rear connections were then looked over, and in taking off the nuts that held the top contact it was found that the thread of the stud had been crossed when screwing it in and the poor contact had caused heating, which had resulted in oxidation and arcing, the stud being half eaten through by it. A new stud was put in, after which no further trouble was found.

Norristown, Penn. WILLIAM H. WATSON.

Drilling with the Vise

The rig shown in the illustration will often solve drilling problems when a drilling machine is not available. A ratchet brace is used for the movement of the drill



METHOD OF DRILLING WITH THE VISE

and the feed is obtained by means of the vise, which is equipped in the manner shown. An angle-plate or any suitable object can be employed for the proper location and backing for the piece to be drilled.

Samuel Gompers, speaking at a dinner recently, said: "The American labor movement, as represented by the American Federation of Labor, is simply this: We believe in progress. We believe that all the fruits of the genius of the past ages and of today do not belong to any particular class—that they belong to every man who gives service to society and aids civilization."

INQUIRIES OF GENERAL INTEREST

Irregular Water Level in Glass Gage—What causes the water in a gage-glass to continually rise and fall? E. E. R.

Fluctuations of the gage-glass water-level may be caused by a surge or wave of the water in the boiler, due to circulation, or it may result from irregular formation or release of steam in the parts of the boiler to which the water column is connected.

Use of Bent Rocker on Valve Motion—Why is a bent rocker used on many high-speed engines for operating the valve rod? J. E. S.

With a symmetrical rocker and a valve with equal laps, the port openings will be equal but the piston positions at cutoff will be very unequal and equalization of the cutoff must be at the expense of the lead. By the use of a bent rocker an irregularity may be purposely introduced into the valve motion that may be made to equalize the cutoff without interfering with the equality of the lead, which is of greater importance than equality of port opening.

Slippage of Riveted Joint—In a riveted boiler joint is movement of one plate over another a sign of poor construction or weakness of joint? F. M.

Samples of carefully constructed riveted joints, when placed in a testing machine, reveal considerable slip long before the working load of the joint is reached. Some slip is unavoidable, for although the rivets when hot may be set with great pressure to completely fill the rivet holes, there is shrinkage upon cooling, and when the friction between the plates is overcome, some slip or "take up" is necessary for the rivets to come to a bearing for resistance against shearing.

Removing Soot from Water-Tube Boiler—Is it a good idea to clean soot from the tubes and baffles of a water-tube boiler by washing down with water from a hose? R. P.

Washing with water should be done only when the boiler is cold and will be injurious to the brickwork of the setting and cause firebrick baffles to crumble if the boiler is used before the setting has been slowly dried out. It is better and also more convenient to remove soot by blowing it off with dry steam, which can be done while the boiler is in use and when there is good draft for carrying off the lightest particles of soot.

Point of Suspension of Stephenson Link—What determines the location of the point of suspension for a link of a Stephenson link-motion valve gear? S. D.

The complex motion of the link and constrained motion of the block give rise to a slippage or rubbing of the link upon the block. The nearer the block is to the point of suspension the less there is of this slippage, and the link usually is suspended nearer the end connected with the forward eccentric rod to reduce the wear for the more common working position. The slippage in backward gear is thereby increased; but when equal efficiency is required in both forward and backward gears, the link is suspended from the center.

Connecting Live-Steam Heating to a Condenser—Is there any benefit in connecting a condenser on heating coils supplied by high-pressure steam direct from the boiler except for the purpose of collecting the condensation for return to the boiler? S. C.

Any form of condenser for continuous operation would be provided with means for discharge of air, and that feature of operation would be beneficial to any system of steam heating to prevent formation of air pockets and thereby increase activity of the circulation of the steam. The heat that is imparted to the condenser is lost if the condensing water is discharged as waste or is of no benefit in increasing the temperature of the boiler-feed water. But for most purposes of live-steam heating, and especially where the steam is used at reduced pressure, a condenser and air-pump connection is of benefit for at least occasional removal of air without extravagant waste of steam, as by blowing out returns and leaving air vents open to the atmosphere. It should be borne in mind, however, that condensation is necessarily accompanied by a drop in pressure and temperature in the heating system, and during operation of the condenser it deprives the heating system of steam that must be made up in the supply, and the heat thus absorbed by the condenser is lost unless utilized.

Negative Part of Indicator Diagram—What is meant by the negative part of an indicator diagram? W. R.

A negative portion of a diagram is any part in which the pressure during the forward stroke of the piston is less than the counterpressure indicated for the same part of the diagram during the return stroke of the piston.

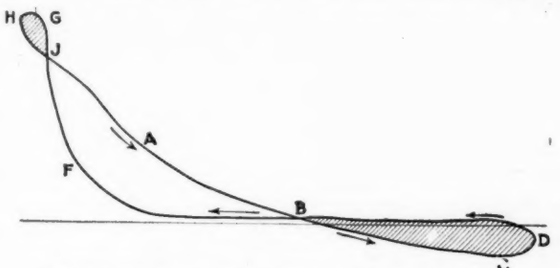


DIAGRAM WITH NEGATIVE AREAS SHADED

When an engine is underloaded, the fraction of stroke at cutoff may be so small that expansion during part of the forward stroke goes below the back pressure during the return of the piston over the same part of the stroke, forming a loop like *BCDEB* shown in the sketch; or the compression line *FG* may rise above the admission line, forming a loop like *GHJ*. The areas contained within such loops are said to be negative because they represent work opposed to the useful work, and in determining the m.e.p., the whole length of the diagram is taken and the negative areas are to be deducted from the area of the rest of the diagram.

Pressure of Compressed Air for Air-Lift Pump—What pressure of compressed air will be necessary for raising water by an air lift from a well 140 ft. deep where the air pipe is submerged to a depth of 60 ft.? T. S.

For operation of an air lift it is best to supply the compressed air at no higher pressure than necessary to inject the air through the footpiece or air nozzle of the lift, for which purpose the receiver air pressure needs to be only great enough for overcoming pipe friction of the air and the pressure of water due to the depth of submergence. A submergence of 60 ft. would require an injection air pressure of $60 \times 0.433 = 25.98$, or practically 26 lb. per sq.in. The loss of air pressure from pipe friction would depend on the size and length of pipe and quantity of air to be delivered. Allowing this loss to be 5 lb. per sq.in., the receiver pressure would need to be $26 + 5 = 31$ lb. per sq.in. If the submergence of 60 ft. becomes less from a drop of the level of water in the well, then the air pressure should be reduced to the pressure for which the greatest discharge is obtained.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Annual Report of the Secretary of the Interior

The annual report of Secretary Franklin K. Lane for the fiscal year ended June 30, 1918, is an exceedingly interesting document, because there is reference to some of the problems produced by the war. Two important recommendations made by Secretary Lane in the report have to do with the returning soldier and the thorough Americanization of the many foreigners now living in the United States. Speaking of a fitting welcome to the returning soldiers, he says:

What shall that welcome be? Is it to be merely one of glad greetings, the emotional outburst of a moment, or shall it take on a more permanent form, one which will be adequate in its largeness and lasting in its nature? Being Americans and being young, they will not ask or expect pensions. They will want work. They will want, if possible, a chance for a home of their own. Now, these hopes, reasonable and manly as they are, can be met in a fashion that will not weaken the fiber of the man by making him an object of bounty and that will add permanently to the strength and the wealth of the nation.

He would do this by making it possible for the returned soldier to obtain a home on land that now lies unutilized, such as swamp land, cut-over land left by logging operations and land needing irrigation to make it productive. There are in the United States at the present time at least 200,000,000 acres that can be converted into farms by irrigation, drainage or clearing, and if the Government undertook the work of making this vast area productive there would be no need of anxiety as to what to do with the returned soldier. Quoting the language of the report again:

The energy and the talent which he has been expending for an ideal and $30 a month he can now use to make a home for himself. There would be laid before him a number of projects which the Government had undertaken in different sections of the country. Let us assume an irrigation scheme, a drainage project, and the development of a body of cut-over lands. The one would need to have great dams, a hydro-electric plant, miles of canal and tunnel, perhaps, thousands of acres to be cleared and leveled, fenced and broken. This would mean years of work at good wages, work in the open, and at the end a piece of land on which would be erected a house and barn, a farm home in a group of farm homes. For this he must pay. But already he has received wages out of which he can have saved the necessary first installment on his place of 10 or 15 per cent. The balance with interest he can pay in 40 yearly installments, or earlier if he can. If the life in Arizona is not to his liking, he can have the same opportunity after building the Arizona irrigated project to take up a farm upon another Government enterprise in South Carolina where men have drained the old rice swamps, or in Wisconsin on a tract of what once was swamp but has been converted into rolling prairie farms.

As to the cost of such an enterprise, the Secretary has this to say:

How great will be the cost? As much as we wish to spend; as much as we need to spend. Less than many a strike has cost this country. Would it be unreasonable to ask for as much as we will spend this year for pensions to the veterans and their dependents of wars that ended 20 and 50 years ago? Would it be unreasonable to ask that we spend in the next two years on these veterans of the great war as much as it cost us to conduct that war for a single week? Would a people that gave out of hand, out of a noble sense of charity to quasi-public organizations, $500,000,000 for the entertainment and care of these boys, hesitate to buy the bonds of this country for a like amount to provide peace work, home work, and homes for these same boys? Canada with less than 7,000,000 people is offering to each man 160 acres of land and $2500 with which to improve it. Surely the United States, which has escaped with so slight a comparative loss in life, will not do less.

Regarding the pressing need of Americanizing the large numbers of foreign-speaking people in this country, Secretary Lane remarks:

The draft revealed the astonishing percentage of those in this country who were unable to speak our language or to read or write any language. Yet there is no one thing so supremely essential in a government such as ours as that every man and woman and child shall know one tongue—that each may speak to every other and that all shall be informed. There can be neither national unity in ideals or in purpose unless there is some common method of communication through which may be conveyed the thought of the nation. All Americans must be taught to read and write and *think* in one language.

What should be said of a democracy which sends an army to preach democracy wherein there was drafted out of the first 2,000,000 men a total of 200,000 men who could not read their orders or understand them when delivered, or read the letters sent them from home? What should be said of a democracy in which one of its sovereign states expends a grand total of $6 per year per child for sustaining its public-school system? What should be said of a democracy which is challenged by the world to prove the superiority of its system of government over those discarded, and yet is compelled to reach many millions of its people through papers printed in some foreign language? What should be said of a democracy which expends in a year twice as much for chewing gum as for schoolbooks, more for automobiles than for all primary and secondary education, and in which the average teacher's salary is less than that of the average day laborer? What should be said of a democracy which permits tens of thousands of its native-born children to be taught American history in a foreign language—the Declaration of Independence and Lincoln's Gettysburg speech in German and other tongues?

The Utilization of War-Time Coal

It is estimated that New England steam-coal consumers had in storage on Dec. 1, 1918, between four and five million tons of coal in excess of their supply on hand a year ago, according to a paper by Perry Barker, consulting fuel engineer, Boston, Mass., presented at the Boston meeting of the A. S. M. E. Mr. Barker pointed out that the source of coal supply for New England has not been materially different than in former years, but that the quality has been lower owing to the urgent need for increased production. The factors that affect the net utilization of coal for steam generation as expressed in the cost of evaporating a unit quantity of water are: (1) Cost per ton, including fixed price at the mine, freight and handling charges to the boiler furnace; (2) increased percentage of noncombustible; (3) increased percentage of volatile matter in fuel delivered to plants not having properly designed equipment for burning coal of such character; (4) decreased efficiency in burning coals not containing excessively high percentages of moisture, volatile matter or ash, but which have very low heating values due to "weathering" or heating in storage; (5) increased cost of evaporation due to poor efficiency and excessive labor and repair charges caused by using coal containing ash of a low fusing temperature.

The effect of increased percentages of ash is shown by the data presented in Tables I, II and III. These figures represent from 15 to 20 shipments of coal in each case and are typical fuels used by New England manufacturing companies. The average difference in heating value between the normal fuel and deliveries for the last year to a mill using low-volatile West Virginia coal was 3.6 per cent. This difference represents very nearly the actual decrease in evaporation per pound of coal, as the addition of this amount of impurities should have no material effect on the efficiency with which the coal is burned. The comparatively small change in quality of the fuel from this district is due to the fact that it is all subject to rigid inspection for navy and bunkering purposes.

The average of deliveries given in Tables II and III shows much greater increases in noncombustible material. These impurities increased the cost of delivering a unit of combustible to the point of consumption, affect the distribution of air in burning the coal, cause excessive loss of combustible in cleaning the fires and entail extra labor charge for handling the ashes.

It has been estimated that the average increase in impurities in fuel delivered is as high as 5 per cent., which would represent 1,250,000 tons of additional noncombustible

that has been transported with the 25,000,000 tons supplied to New England this year. In one plant burning about 10,000 tons of coal per year, the cost due to handling ashes alone was increased to more than $2.50 per ton, which represented an additional charge of $3800 for the year.

Table IV shows the results of tests of three deliveries to plants normally using fuel of the quality given in column 1. The coal in column 2 was used in a hand-fired plant having return-tubular boilers with low settings. The firemen reported that the coal was "flashy" and made steam quickly, but with a firing interval of 20 to 30 minutes a large loss due to incomplete combustion resulted.

The figures in column 3 of Table IV illustrate a type of fuel that has been delivered to New England during the past year. This "outcrop" coal is loaded from seams that have been exposed and has lost a part of its combustible volatile matter. Coal of this character will not coke in the boiler furnaces, causing uneven distribution of air and excessive loss of combustible to the ashpits. The shipment of "outcrop" coal has been stopped by the Fuel Administration and about 200 mines responsible for such fuel have been closed.

The coal shown in column 4 of Table IV is of the most troublesome character, due to the low fusing temperature of the ash. It will be noticed that this figure is 430 deg. F. below the coal used prior to 1918. The low fusing temperature caused excessive clinkering, particularly at the high rates of combustion necessitated by the overloaded condition of the boilers.

TABLE I. WEST VIRGINIA LOW-VOLATILE COAL

	Normal Per Cent.	Average 1918, Per Cent.	High Ash 1918, Per Cent.
Moisture	2.50	3.11	2.48
Volatile matter	17.50	17.91	18.42
Fixed carbon	74.00	70.83	68.98
Ash	6.00	8.15	10.12
	100.00	100.00	100.00
Sulphur	0.65	0.63	0.73
B.t.u. per pound	14,410	13,886	13,656

TABLE II. PENNSYLVANIA LOW-VOLATILE COAL

	Normal Per Cent.	Average 1918, Per Cent.	High Ash 1918, Per Cent.
Moisture	2.50	4.74	6.82
Volatile matter	18.50	26.09	26.00
Fixed carbon	71.50	57.19	44.67
Ash	7.50	11.98	22.51
	100.00	100.00	100.00
Sulphur	1.40	1.12	1.47
B.t.u. per pound	14,125	12,554	10,047

TABLE III. PENNSYLVANIA STEAM SIZES OF ANTHRACITE

	Normal Per Cent.	Average 1918, Per Cent.	High Ash 1918, Per Cent.
Moisture	4.50	6.92	6.77
Volatile matter	5.00	5.74	4.40
Fixed carbon	74.50	67.12	57.50
Ash	16.00	20.22	31.33
	100.00	100.00	100.00
Sulphur	0.80	0.52	0.42
B.t.u. per pound	11,775	10,440	8,635

TABLE IV. TYPICAL CHANGES IN CHARACTER OF COAL FOR NEW ENGLAND STEAM PLANTS

	Normal Coal Per Cent.	War-Time Fuel Supply Per Cent.	Per Cent.	Per Cent.
	1	2	3	4
Moisture	2.50	4.28	16.87	0.62
Volatile matter	18.50	34.12	28.00	19.36
Fixed carbon	71.50	47.16	44.50	67.90
Ash	7.50	14.44	10.63	12.12
	100.00	100.00	100.00	100.00
Sulphur	1.20	1.94	0.46	3.61
B.t.u. per pound	14,150	12,074	8,990	13,543
Fusing temperature	2550 deg. F.			2120 deg. F.

Electric Welding in Shipbuilding

On the evening of Dec. 30, Comfort A. Adams, president of the American Institute of Electrical Engineers, gave an interesting talk on "Electric Welding in Shipbuilding" before a joint meeting of the Chicago section of the society and the electrical section of the Western Society of Engineers. Mr. Adams outlined the activities of the committees of the American Institute of Electrical Engineers which had assisted in the development of electric welding practice in the shipbuilding industry. He compared briefly arc and spot welding, giving interesting data on the cost of the equipment, the electrical energy required and the strength of the welded joints. The speaker was optimistic as to the success of electric welding in shipbuilding. The savings over riveted construction are considerable. This is evidenced by the comparative cost figures for constructing American and English ships. At the present time the cost to American shipbuilders is about $200 per dead-weight ton, while the English yards have recently offered to produce all the ships America desires at a cost of $100 per dead-weight ton for the completed ship. As electric welding requires the use of less steel, produces vessels of less weight and hence a greater carrying capacity, and effects a considerable saving in labor, it offers an excellent opportunity for reducing the cost of ships made in America.

At a business session of the electrical engineering section of the Western Society of Engineers, during the evening the following officers were elected: Chairman, J. R. Cravath; vice chairman, Harold Almert; director for three years, M. M. Fowler.

Personal Mention

Osborn Monnett, who has just returned from Washington, where he has been serving as assistant advisory engineer, Bureau of Conservation, U. S. Fuel Administration, has opened offices at 1785 Old Colony Building, Chicago, for the practice of consulting engineering. He is specializing in combustion, boiler settings and general power plant problems. Mr. Monnett will be associated with the Commercial Testing and Engineering Co., chemists and coal specialists. The combination is a good one as the services rendered will fully cover all chemical and mechanical problems from the time the coal is purchased to the delivery of the energy at the switchboard. Mr. Monnett has had broad experience which should be invaluable in his new work. Formerly, he was consulting combustion engineer for the American Radiator Co., chief smoke inspector for the City of Chicago, associate editor of *Power*, and back of this he has had many years of practical experience in the operating steam engineering field, both stationary and marine.

Angus Sinclair

Angus Sinclair, D. E., founder and for the last 32 years editor-in-chief of *Railway and Locomotive Engineering*, died Jan. 1, 1919, at his home in Millburn, N. J. He was born at Forfar, Scotland, began his railroad career as a telegraph operator and learned engineering at the shops of the Scottish Northeastern Ry. at Arbroath. After some service as a marine engineer, he came to America and again took up railroading, first with the Erie, and later as a locomotive engineer on the Burlington, Cedar Rapids & Northern. He attended the chemistry classes of the Iowa State University and was later appointed chemist on the railway, combined with the duties of roundhouse foreman. It was during this period that he first gave serious attention to the problem of fuel economy and smoke prevention. His methods met with considerable opposition at first, but are now universally approved.

In 1883 he joined the editorial staff of the *American Machinist* and later became proprietor and editor of *Railway and Locomotive Engineering*. In a short time this paper became a leading authority in its field and has maintained its high character and standing ever since. Dr. Sinclair was the author of many popular books on engineering subjects. In 1908 he received the honorary degree of Doctor of Engineering from Purdue University. He was closely identified with the work of many of the leading engineering societies in America and with some of the same kind in Europe. He was elected a member of the American Railway Master Mechanics Association in 1873. He served as secretary of the association from 1887 to

1896, was elected treasurer in 1900 and served continuously until the time of his death. He became a member of the Master Car Builders' Association in 1873 and the American Society of Mechanical Engineers in 1883. He was the first president of the New Jersey Automobile and Motor Club. He was a delegate to the International Railway Congress held at Washington, D. C., St. Louis, Mo., and Berne, Switzerland.

Among the societies which he aided in establishing was the Traveling Engineers Association, founded in his office in 1892. He was a Knight Templar in the Masonic fraternity, a governor in the St. Andrew's Society, ex-president of the Burns Society and also of the St. Andrew's Society of Newark, besides being a member of the American Railway Guild, Lawyers Club, New York Railroad Club, and numerous other railway, Scottish and other societies.

New England Fuel Crisis Ended: Mr. Storrow Resigns Post

James J. Storrow of Boston, Federal Fuel Administrator for New England, has offered his resignation to Dr. Garfield with the statement that both hard and soft coal conditions are now satisfactory. Mr. Storrow stated in announcing his resignation that for several weeks New England has been well stocked with soft coal and needed no further attention on his part. The domestic hard coal situation is now satisfactory and can safely be left to the regular trade channels to carry the market through the balance of the winter.

From Apr. 1 to Dec. 1, 1918, New England received 20,187,670 tons of soft coal as compared with 16,469,866 tons in the corresponding period of 1917. The conservation work is estimated to have saved New England at least a million tons of coal, and in addition a large increase has been brought in in the steam sizes of anthracite. Mr. Storrow said that counting all these factors, the steam-coal users of New England are 33 per cent. better off this year than a year ago. More soft coal could have been brought in during the past thirty days if needed, but the district is now thoroughly supplied and from now on will need considerably less than normal current shipments. During the entire twelve months of the coal year which ended Apr. 1, 1917, the last practically normal year, New England received 9,893,000 net tons of domestic sizes of hard coal. During the first eight months of the present coal year 8,108,000 tons have been received. As a result of this large increase in the movement of hard coal into New England, aided by the mild weather and the coöperation of householders in conserving fuel, domestic users can now look forward without fear of any repetition of the experience of a year ago. Mr. Storrow said:

New England owes a debt of gratitude to Harry A. Garfield, a man of high moral purpose, eager to stand fast for the right. When he saw that New England, due to the long distance from the mines, the tremendous war pressure of our industries, the blockading of our railroads, the loss of our tugs, the taking of our colliers and the difficulties of winter movement along the coast, must be given an offsetting consideration, he never hesitated to go to the point where he felt the equilibrium of equal justice for all sections was established. Beyond this we believe we never asked him to go. Beyond this his character made it impossible for him to go.

At the very worst and most critical day of last winter's danger and distress William G. McAdoo was appointed director general of railways. On Sunday afternoon, at his home, within forty-eight hours of his appointment, he gave us effective aid. If this had not come on that day, New England would have been in a plight which, fortunately, no one but the New England fuel administrator, sitting in his office, to which all the threads from all New England ran, could know, and which, indeed, we think New England can never know or realize.

The local fuel committee of Massachusetts has performed a signal public service. The work has been anxious and laborious. Our Massachusetts cities and towns were face to face with one of the most menacing situations ever encounterd in their history. I believe every state in the Union outside of Massachusetts contented itself with merely a county administrator. We reached down into every town and city, where a hard-working chairman and an efficient committee have done their community patriotic public service probably but little understood, but without which there would have been great anxiety and distress. If the Massachusetts administration had not rested on the firm basis provided by these 312 chairmen and committees, our efforts would have been largely unavailing and quite ineffective. May I say that it has been to me a great satisfaction and pride to be working with such a body of men? As I have come to know them, to realize the unselfish way in which they have assumed their hard task, how they kept their heads during anxious days, what sound judgment they have over and over displayed, and how they have commanded the respect and confidence of their communities, I have said to myself, "These men are the pith and sinew of New England. They are the kind of men who have made the proud and successful history of this comparatively bleak and sterile little corner of this great country."

Professor Rateau Honored

Professor Auguste C. E. Rateau, inventor of the Rateau turbine, has been named a member of the Académie des Sciences. The recipient of this well-deserved honor was born in 1865. He was authorized by the French government, at the age of 18, to compete for admission to the École Polytechnique of Paris. This authorization was necessary on account of his being under age for such a competition. He was admitted and left the school after the examination carrying the number "one." This honor is held very high in France and is very dear to Professor Rateau. From this school were graduated Joffre, Foch, Castelnau and Petain. Professor Rateau then went to the École Supérieure des Mines, where he followed the postgraduate course, and, at the age of 23, was named professor of higher mathematics at the École des Mines at St. Etienne. Later on he was named professor in the École des Mines de Paris, where he held in succession all the chairs referring to mathematics, mechanics and electricity.

Some twenty-five years ago Professor Rateau completed tests on the flow of steam and investigated the technical problems involved in the design of steam turbines. He patented the resulting designs and placed on the market the type of steam turbine bearing his name. This type of machine has been adopted partly or entirely by practically all of the manufacturers in this country and abroad.

Rateau was the first to realize the great savings to be obtained by the use of low-pressure steam in turbines. His inventions and designs in this field are steam regenerators, permitting the use of intermittent exhaust steam from reversing engines to be used in condensing steam turbines, mixed-pressure turbines, turbine regulators, etc. There are over two million horsepower of steam regenerators in this country and abroad, and over three million horsepower of mixed-pressure turbines.

The work of Professor Rateau on the theory, design and operation of rotary fans and pumps is well known. He was the first to develop the centrifugal turbo-compressor. The first hundred-pound compressor was built by him in 1889. These machines have since come into general use, many being used in steel works and copper works, to produce the blast for blast furnaces, converters, smelters, etc.

In naval work Professor Rateau has done a great deal, and a number of battleships, destroyers, torpedo boats, etc., are equipped with his machines. In this country three electrically driven tank boats of the Mexican Petroleum Co. are equipped with Rateau turbines. Among the firms manufacturing in this country under Rateau licenses are Westinghouse Electric and Manufacturing Co., General Electric Co., Ingersoll Rand Co., Ridgway Dynamo and Engine Co., Southwark Foundry and Machine Co. and Terry Turbine Co.; in Canada, the Dominion Bridge Co.; in England, Fraser & Chalmers Co., British Westinghouse Co. and Adamson & Son.

In airplane work Professor Rateau has not been idle. He has studied the resistance of planes in the air, and during the war designed and placed in operation, on board

airplanes, an apparatus which has not yet been disclosed to the public, which gave new possibilities in airplane propulsion.

As an industrial, Professor Rateau is the founder of the Société Rateau in Paris, having shops in France and Belgium. He has always been directly connected and associated with the Rateau Steam Regenerator Co. and the Rateau Battu Smoot Co. in this country.

The hydro-electric works at Lake Coleridge, New Zealand, have been so successful that not only is the Government convinced by their success of the practicability of developing other schemes, but the general public is prepared to press the authorities to proceed with the large program which has been drawn up. The program provides for a series of schemes designed to supply the whole of the North Island with hydro-electric power from three sources, eventually to be linked together. The Chief Electrical Engineer to the Government, in a report on the possible development of hydro-electric schemes in the North Island, suggested the utilization of waters of the Mangahao River, the Waikato River and Lake Waikaremoana; the first to supply the southeast and southwest, the second the center and northwest, and the third the northeast of the North Island. It was suggested that the first two should be proceeded with at the earliest possible moment, and that the third should be deferred until railway communication in the Hawkes Bay and Poverty Bay districts had been improved.—*The Engineer.*

New Publications

ELECTRICAL BLUE BOOK.—Published by the International Trade Press, Inc., Chicago, Ill. 1918. Cloth, 9 x 12 in.; 274 pages; Illustrated. Price, $2.

This book, which has become so well known to those in the electrical industry, is now published in its eighth edition. The text is divided into seven parts: Catalog Exhibits of Electrical Apparatus and Materials; List of Underwriters' Laboratories, Branch Offices and Inspection Stations; List of Inspected Electrical Apparatus and Material, as examined and approved by the National Board of Fire Underwriters, up to Apr. 1, 1918; The National Electrical Code, Explained and Illustrated; List of Members of the Electrical Supply Jobbers' Association; Directory of Electrical Associations; and Complete Buyers' Guide of Electrical Apparatus and Material. The National Electrical Code for 1918 is published in full, with explanatory notes and illustrations showing simple and practical methods for fulfilling these official requirements. The Book as a whole is a comprehensive source of practical electrical information as well as a buyers' encyclopedia.

Obituary

John E. Williams, formerly fuel administrator for Illinois, and widely known as an arbitrator in industrial disputes, died at his home in Streator, Ill., on Jan. 2, after an illness of several months. In addition to his duties as fuel administrator, he was United States administrator for the packing industry and labor arbitrator for Hart, Schaffner & Marx. He was 65 years old. He is survived only by his widow.

Personals

Lieut. Louis O. Monroe has returned to the Clarage Fan Co., Kalamazoo, Mich., as manager of sales and chief engineer. Mr. Monroe was in charge of the Chicago office of the company before entering the service.

C. W. Bell, formerly assistant chief engineer, Hauto Power Station, Lehigh Navigation Electric Co., is now superintendent of power plants, Northumberland County (Penn.) Gas and Electric Co. and the Columbia and Montour Electric Co.

W. L. Bigelow is now Eastern salesman for the Sanford Riley Stoker Co., of Worcester, Mass., and the Murphy Iron Works of Detroit, Mich., directing sales and services of the Riley underfeed stoker and the Murphy automatic furnace, with offices at 1226 Woolworth Building, New York City.

Engineering Affairs

The American Society of Heating and Ventilating Engineers will hold its annual meeting in New York City, Jan. 28-30.

The Marine Engineers' Beneficial Association will hold its annual convention at Buffalo, N. Y., during the week beginning Jan. 20. The Hotel Statler is the headquarters.

The American Society of Mechanical Engineers announces that the following sections will hold meetings: At the Engineers' Club, Philadelphia, Jan. 28; at the Hotel Statler, Buffalo, N. Y., Jan. 29.

Business Items

The Vanadium-Alloys Steel Co., of Pittsburgh, Penn., has leased offices and warerooms at 566-568 West Randolph St., Chicago, in order to carry a larger stock to meet the growing demands of customers in this territory.

The Penberthy Injector Co. has produced its one-millionth injector. In days when the talk is in billions, a million makes little impression. Yet, it is one thousand thousands. Hence, for the 30 years during which the Penberthy company has been manufacturing injectors the average production was about 3000 per month. Something like 6,000,000 lb. of copper was melted to make them and they would feed 50,000,000 boiler horsepower. The Penberthy company began to make injectors in 1886 at Detroit, Mich., in a one-room plant of about 144 sq.ft. of floor space and equipped with one small lathe. Today, the company's plant covers 2½ acres and is one of the best-known and equipped in the high-grade brass specialty field.

Trade Catalogs

The Hess-Bright Manufacturing Co., of Philadelphia, has issued a 108-page catalog (Form 881) entitled "The History and Development of Ball Bearings." It is fully illustrated, contains numerous tables and much useful information.

A. S. Cameron Steam Pump Works, 11 Broadway, New York, have issued a twelve (12) page bulletin on pumps for marine service. This bulletin shows sectional and complete views, as well as description and tables, that will be of service to anyone interested in the subject of marine pumps.

New Construction

PROPOSED WORK

Conn., Bridgeport—The city plans to build Black Rock intercepting sewer and laterals and an auxiliary pumping station at Harborview Ave. and Gilman St. Estimated cost, $160,000. J. A. McElroy, City Engr.

Mass., New Bedford—The Whitman Mills Corporation, Coffin Ave., plans to build a 1-story, 12 x 30 ft. transformer house. Z. B. Davis, Corporation, 668 Acushnet Ave., Arch.

Conn., Hartford—S. Z. Pole, 24 Church St., New Haven, will install a steam heating system in the 3-story, 120 x 158 theater which he plans to build on Main St. Total estimated cost, $125,000. T. W. Lamb, 644 8th Ave., New York City, Arch.

N. Y., Cohoes—The Board of Education will install a steam heating system in the 2-story high school building which it plans to construct in the spring. Total estimated cost, $210,000. Tooker & Marsh, 101 Park Ave., New York City, N. Y., Engr.

N. Y., Fulton—The Oswego Falls Pulp & Paper Co. plans to install a heating and ventilating system in its plant. Estimated cost, $40,000. Elmer E. Palmer, Snow Bldg., Syracuse, Consultg. Engr.

N. Y., Ithaca—The Ithaca Traction Co., 113 East State St., plans to rebuild its power house recently destroyed by fire, entailing a loss of $75,000.

N. Y., Little Falls—H. P. Snyder Manufacturing Co. plans to remodel its heating, ventilating and power plant. Estimated cost, $10,000. Elmer E. Palmer, Snow Bldg., Syracuse, Consultg. Engr.

N. Y., Long Island City—The White Co., Park Ave. and 57th St., New York City, will install a steam heating system in the 1½-story, 200 x 600 ft. factory building which it plans to construct on Thompson, Nott, Mound and School St. Total estimated cost, $500,000. Watson Engineering Co., 1101 Hippodrome Bldg., Cleveland, Ohio, Engr.

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until January 20, for the construction of a heating plant in the Navy Yard here. C. W. Parks, Chief.

N. Y., South Colton—The Aluminum Co. of America, Oliver Bldg., Pittsburgh, Penn., has purchased flowage rights and site at Three Falls Power, just above here and plans development.

N. Y., Stark—The Aluminum Co. of America, Oliver Bldg., Pittsburgh, Penn., plans to develop the power on the Racquette River.

N. Y., Utica—The State Hospital Commission, Capitol, Albany, will soon receive bids for installing boilers, piping, etc., in the Utica State Hospital. Estimated cost, $75,000.

N. J., Asbury Park—The First Methodist Episcopal Congregation plans to install a steam heating system in the 2-story, 70 x 190 ft. church which it plans to build. Total estimated cost, $150,000. Lucian E. Smith, 2 West 47th St., New York City, N. Y., Arch.

Md., New Windsor—The B. F. Shriver Co. is having plans prepared by J. F. Roystone Engineering Co., Times Bldg., Westminister, for the construction of power house and canning factory.

Ga., Atlanta—R. C. Turner, City Electrician, recommended that city build an electric plant for the purpose of utilizing the steam which is going to waste at the crematory. Estimated cost, $70,000. H. L. Collier, City Engr.

Tenn., Bristol—A. L. Womack & Co. plans to build a refrigerating plant in connection with the poultry plant which it plans to construct.

Tenn., Memphis—The City Commission will soon award the contract for the installation of a heating plant at the North Memphis pumping station.

Ohio, Ashtabula—The city plans to double the capacity of its lighting plant. Plans include the installation of another 1000 h.p. boiler as well as some minor equipment.

Ohio, Sulphur Springs—The Central Power Co., Canton, plans to extend its mains from the line north of Sulphur Springs where the new main will cut across from New Washington to Crestline, into the city to serve the people. F. H. Golding, Canton, Gen. Mgr.

Ind., Richmond—The Board of Public Works, City Hall, plans to improve the hydroelectric light plant. D. B. Davis, City Engr.

Mich., Ford (Wyandotte P. O.)—The village is in the market for an 8-in. pump having a capacity of 4000 gallons per minute, driven by a 25 hp. gasoline engine as auxiliary, to be installed in the

sewerage pumping station. M. L. Brown & Son, 824 Chamber of Commerce Bldg., Detroit, Engr.

Mich., Grand Rapids—The Dominican Sisters plan to install a steam heating plant in the 4-story convent which they plan to build. Total estimated cost, $350,000. E. Briermaier & Sons, 111 Mason St., Milwaukee, Wis., Arch.

Ill., Chicago—The Kercher Hotel & Bath Co., 505 South Wabash Ave., plans to install a high pressure steam heating system in the 12-story, 80 x 170 ft. hotel which it plans to build at 414 South Wabash Ave. Total estimated cost will run over $1,000,000. Walter W. Ahlschlager, 133 West Washington St., Arch.

Ill., Springfield—The city voted a $60,000 bond issue for the construction of a lighting system in the business centre and down town section. Wade Seeley, City Engr.

Wis., Milwaukee—The Robert A. Johnston Co., 270 Florida Ave., plans to install a steam heating system in the 7-story, 135 x 310 ft. candy and biscuit factory which it will build on National Ave. and 34th St. Plans include the construction of a power house. Total estimated cost, $500,000. H. J. Esser, 402 Camp Bldg., Arch.

Wis., Oconto Falls—Frank F. Becker and C. H. Hartley plan to build a hydroelectric plant and dam between Oconto Falls and Gillett. Mead & Seastone, Madison, Engr.

Wis., Prairie Du Chien—The Mid-Continental Utilities has applied to the City Council for a franchise to build transmission line from the city limits to the power plant. C. Grelle, Pres.

Minn., Hibbing—The village plans to build an electric light and power plant. Estimated cost, $500,000. Charles Foster, Mgr.

S. D., Beresford—C. H. Green has applied to the City Council for a franchise to build an electric light plant.

S. D. Burke—The city voted a bond issue for the construction of an electric light plant.

Wyo., Sheridan—The Sheridan County Electric Power Co., controlled by the Federal Light & Traction Co., plans to improve its local plant. Judson Hibbs, Mgr.

Mo., Kansas City—Swift & Co., Union Stock Yards, Chicago, Ill., will soon award the contract for the construction of a 3-story, 75 x 100 ft. addition to its boiler house on Adams and Berger St. S. A. Middaugh, Purchasing Agent.

Mo., Macon—Frank L. Wilcox, Engr., Syndicate Trade Bldg., St. Louis, made examinations and submitted report to the City Council recommending the following improvements to the electric light plant: The installation of unaflow engine, 125 lbs. steam pressure, 26 vacuum, 164 r.p.m., direct connected to 350-400 k.v.a. generator with belted exciter, $27,500; above unit delivered and erected complete, including foundation, piping connections and electrical connections, the said piping connections to include steam and exhaust pipe, suction and discharge piping for condenser with atmospheric exhaust stack, automatic relief valve, exhaust head, steam separator, trap and oil separator with neccessary valves and fittings, $35,000; surface condenser for 250-400 k.v.a. unit with combination circulating and vacuum pump, including spray system, cast iron piping and connections for same, delivered and erected ready for, but not including steam exhaust, suction and discharge piping (same being included in above $35,000 item) $6,350; combination exciter and voltage regulator panel, $750; concrete spray pond 60 x 80, 120 cu.yds. Reinforced concrete at $21, $2,520; other incidentals bringing total cost to $55,000.

Mo., Richmond—The City Council plans to install 2 new boilers and other machinery in the water-works.

Mo., St. Louis—The Hussmann Refrigerator Co., 911 North Broadway, will install steam heating plant, sprinkler system and electric motors in the 1-story, 130 x 200 ft. factory which it plans to build on Leffingwell Ave. and North Market St. Total estimated cost, $50,000.

Tex., Cisco—The Cisco Gas & Electric Co. plans to remodel its plant and build power and ice plants.

Tex., McAllen—The Rio Grande Public Service Corporation plans to improve and enlarge the electric light plant, water system, and ice plant. Plans include the installation of machinery which will more than double the present capacity.

Okla., Covington—The city plans an election to vote on a $40,000 bond issue for the installation of an electric plant, waterworks and sewerage system. Address the Mayor.

Colo., Denver—The Cities Service Co., 60 Wall St., New York City, N. Y., has purchasing the controlling interest in the Western Light & Power Co. and plans improvements. Equipment to cost $1,250,000 will be installed in same. Frank W. Frucauff, New York, Vice Pres.

Utah, Ogden—The city plans to build a power and light plant. Estimated cost, $50,000. J. M. Tracy, City Engr.

Cal., Calexico—The City Trustees plan to build an electric-light and power plant.

Que., Verdun—J. P. Dupuis, 592 Church St., is in the market for a sawmill with 60 to 70 h.p. engine.

Ont., Alvinston — The Hydroelectric Commission of Ontario, University Ave., Toronto, plans to remodel the electric light plant here. Estimated cost, $40,000. F. A Gaby, Engr.

Ont., Goderich—The National Shipbuilding Co. is in the market for a 6 ft. radial drill for boiler shop; lathe to take in 12 ft. between centers; air hoists 10 in. cylinder, 4 ft. lift with trolley; vertical air receiver, 44 in. inside diameter by 14 ft. high.

Ont., Owen Sound—The North American Bent Chair Co. is in the market for several electric motors.

Ont., Smith Falls — The Hydroelectric Power Commission plans to install two 1000 imperial gallon centrifugal pumps and one 800 imperial gallon booster pump for the water system, both to be electrically driven by hydro power.

B. C., New Westminister—The New Westminister Co-Operative Association plans to build a cold-storage plant. Estimated cost, $70,000.

B. C., Vancouver—The Pacific Great Eastern Railway Co. plans to develop electric power along its line in the province. George L. Courtney, Gen. Mgr.

CONTRACTS AWARDED

Vt., Bellows Falls—The Bellows Falls Power Co., c/o Charles Harriman, Inc., 50 Congress St., Boston, Mass., has awarded the contract for the construction of a hydroelectrc plant on Bridge St., to the Power Construction Co., 35 Harvard St., Worcester, Mass.

Mass., Chatham—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a boiler house, heating system, etc., here, to Coleman Bros., Chelsea.

N. Y., Thiells—L. F. Pilcher, State Architect, has awarded the contract for installing a heating plant in the attendants home and service building, at Letchworth Village, to Miller-Grady, 210 East 38th St., New York City, $4477; electric work, to the W. H. Strant Co., 14 New Main St., Haverstraw, $2000.

N. J., North Bergen—The Board of Education has awarded the contract for installing a heating and ventilating system in P. S. No. 7, to Edward Beck, 716 Bergenline Ave., West New York. Estimated cost, $8148.

Penn., Pottsville—Bernard Schmidt, 13th and Walnut St., has awarded the contract for the construction of a 1-story, 134 x 134 ft. bakery to include a boiler house, to E. N. Lebo, 1922 Berryhill St., Harrisburg. Estimated cost, $30,000.

Wis., Manitowoc—The Burger Boat Co. has awarded the contract for installing motor and power transmission equipment, including a 185 h.p. motor, to the L. J. Anderson Electric Co.

Mo., St. Joseph—Swift & Co., Union Stock Yards, Chicago, Ill., has awarded the contract for the construction of a 3-story, 51 x 52 ft. addition to its power house, to the Lehr Construction Co., 1712 Frederick Ave. Estimated cost, $40,000.

Cal., Martinez—The city received lowest bid for furnishing pumping and electrical equipment for the water-system, from Fairbanks-Morse Co., 651 Mission St. San Francisco, at $6015.

Cal., San Pedro—The Union Ice Co., 660 South Alameda St., Los Angeles, has awarded the contract for the construction of a 1-story, 50 x 100 ft. cold storage and ice making plant on Mesa Ave., to C. M. Gray & Sons, 2650 Santa Fe Ave. Estimated cost, including equipment, $30,000.

Que., Temiskaming—The Kippewa Fibré Co. has awarded the contract for the construction of twenty 1-story, concrete buildings to be used as sulphite paper mills, to George A. Fuller Co., 45 St. Alexander St., Montreal. A steam heating system will be installed in same. Total estimated cost, $3,000,000.

B. C., Vancouver—The Foundation Co., Ltd., has awarded the contract for furnishing marine boilers, to the Vulcan Iron Works, Granville Island. Estimated cost, $1,000,000.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$6.55	$7.30	Broken	$7.80	$8.55
Buck.	5.10	5.90	Egg	7.70	8.45
Rice	4.65	5.10	Stove	7.95	8.70
Barley	4.15	4.30	Chestnut	8.05	8.80

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b., Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$4.80	$3.40	$6.05	$4.30
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.50
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70	$3.25—3.40
Mine-run	2.35—2.50	3.00—3.15
Screenings	2.05—2.20	2.75—2.90

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene,			

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10.

other rates p. 95.